BRITISH & COLONIAL DAIRYING

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TO

PROFESSOR R. J. DRUMMOND

OF THE DAIRY SCHOOL FOR SCOTLAND, IN
RECOGNITION OF HIS SPLENDID SERVICES
AS A TEACHER OF PRACTICAL DAIRYING

[Frontispiece.

Group of Students at the Dairy School for Scotland (M'Gregor, Kilmarnock).

BRITISH & COLONIAL DAIRYING

FOR SCHOOL, FARM, AND FACTORY

BY

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PREFACE

In the publication of this book an attempt is made to put into plain, practical language information that will assist to correct errors which are preventing a healthy development of important phases of the Dairying Industry. It is the author's belief that Dairying and Dairy Farming have been seriously handicapped through the faulty recognition of practical and commercial subjects that are inseparable from success.

If this work succeeds in drawing the attention of responsible authorities to the necessity of correcting existing errors, and disseminating helpful knowledge amongst the right class of workers, its publication will be amply rewarded.

The author's experience of Agriculture and Dairying has shown that in Britain there is an inclination to give too much attention to theoretical instruction and to underestimate the value of practice. One is compelled to admit there is much truth in the axiom, "An ounce of practice is worth a pound of theory."

It may be necessary to point out that "British and Colonial Dairying" will take the place of "Dairying for all Countries," which is referred to in the author's last book, entitled "Milk and Cream Testing and Grading Dairy Produce."

G. SUTHERLAND THOMSON.

LONDON, *October* 1913.

INTRODUCTION

The author of "British and Colonial Dairying" set himself a somewhat difficult task when he planned to write a book on the subject of dairying that would be equally acceptable and useful in different parts of the Empire. It is true that the principles which apply in the production of milk and in the manufacture of dairy products are the same everywhere, but there are important differences in the methods which are followed in Australasia as compared with the mother country, and it is often difficult to persuade the average dairyman to distinguish between the underlying principles and those things which relate merely to the practice of his art.

Having had some personal experience in dairying operations in the different countries included in the term "British and Colonial," I am ready to say that the author has succeeded admirably in the object which he had in view.

The science of dairying is of very recent origin compared with the antiquity of the art, and it is the business of the dairy teacher or writer to apply the lessons of science to everyday practical work.

Mr Thomson's effort in this direction is an important contribution to the somewhat scanty and fragmentary literature on the subject.

In these days of inter-imperial, to say nothing of international trade in dairy products, it would seem to be quite in order to treat the home and colonial aspects of the dairying industry under one head and within the covers of a single book.

Australia and New Zealand are likely to grow in importance year by year as sources of the United Kingdom's supply of butter and cheese. Canadian dairy produce, which does not, as a rule, come under the description of colonial, is being required more and more every year to feed the growing population of the Dominion, and, until there is some change in the attitude of the Canadian Prairie farmers towards stock raising, there is not likely to be any large increase in the exports of butter and cheese from Canada.

Dairy farmers, cheese-makers, and butter-makers will find much that is interesting as well as instructive in the pages of this book. The whole field of dairying is well covered, and the author is to be congratulated on his clearness of statement and the excellent arrangement of his material.

J. A. RUDDICK,
Dairy Commissioner for Canada.

OTTAWA, CANADA,
1st September 1913.

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BRITISH AND COLONIAL DAIRYING

CHAPTER I

THE MILK SUPPLY

Composition of Milk

BEFORE entering into the subjects of practical butter-making and cheese-making the author will deal in a general way with the milk and cream supply, preference being given to questions having a practical, commercial, and scientific relationship with the title of this work. Readers will recognise the importance of such a step, as it will give a clearer understanding of many factors that are associated with, and responsible for, the successful manufacture of dairy produce. Additional matter will be included in the various chapters which will add to the interest of the work.

Milk is secreted by the mammary glands in the vessel of the cow. Its composition depends upon the quality of the blood, and the activity of the milk-producing organs, which are influenced by internal and external conditions. To the scientist milk is a complex substance, and its formation is still unsatisfactorily explained, but there are a number of practical deductions which show to the farmer what is necessary to maintain a healthy flow. The composition of milk varies considerably, and its value chiefly depends upon the relative proportions of the chief constituents—fat, casein, and sugar.

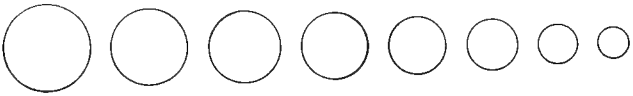
We shall deal briefly with each, to illustrate what special place they occupy in normal milk.

Fat.—This is the most valuable element and exists in globules of varying size, according to the breed of the cow, and other minor conditions. The globules are so finely and thickly distributed, that it has been asserted by an authority on the subject that 1,500,000 are contained in the tiniest drop. They comprise stearin, palmitin, olein, and butyrin, which may be termed the hard, soft, and liquid fats, while the others are of a volatile nature and need not be mentioned, more than that they are associated with the aroma of butter. By centrifugal force, fat is separated from milk, and so perfect is the system that a very small percentage is left in the milk. The proportion of fat varies in milk, the first drawn being comparatively poor, while the last is very rich.

One of the characteristics of fat, compared with the other constituents, is its lightness, and this is shown when new milk is left undisturbed for a time. Under certain conditions cream quickly rises to the surface, and when examined microscopically there is a high percentage of large globules, the small ones, having proportionately a greater surface exposure, do not rise so rapidly. To increase the separation of fat in milk by the old system of "setting," heat is applied to the milk, after which it is cooled. Such a practice is still commonly followed by householders, and a characteristic feature is, it gives to the cream a distinctly bright colour. This is because the fat retains its heat longer, and being light it reaches the surface in a concentrated condition. The non-fatty solids absorb the cold more quickly, thereby facilitating the rise of the fat. It is fortunate that fermentation does not have a very destructive effect on the fats.

Milk containing a high percentage of fat has a corresponding high proportion of albuminoids, and it generally follows with breeds and individual cows that a high fat reading accompanies a high percentage of total solids. In different breeds the size of the fat globules varies, and the richer the milk the greater the number of large globules, although with individual animals of a breed this may not always occur. Shorthorn cows may be taken as an example of irregularities in the size of the fat globules.

The following will more clearly describe features above referred to :—

Breed.	French Parthenay.	Jersey.	Guernsey.	Simental.	Shorthorn.	Ayrshire.	Holstein.	Montafoner.
Comparison of Fat Globules.								
Average Fat Percentage.	5·0	3·9	3·9	3·7	3·6	3·5	3·2	2.8
Average Total Solids.	15.20	14.60	14.40	12.70	12.60	12.60	12.00	11.60

Breeds of cows giving small quantities of milk generally yield a high percentage of fat, and this applies very forcibly to draught cattle, that have not had their milking qualities developed. Breeds giving poor milk fluctuate less in the fat content, and other solids, than breeds giving rich milk. When we consider the buffalo, however, there are features associated with the milk supply that are decidedly interesting and form the basis of useful investigation, and the same may be said of the sheep, mare, and some foreign breeds of cattle that have not been studied generally. The milk of the buffalo varies very little in the solids not fat, and this is noticeable throughout the whole period of lactation, and as the flow decreases the proportion of fat alters but slightly. Individual buffaloes of a breed fluctuate more in the milk yield than is found in the case of cattle. The milk is exceptionally rich, and 7 to 8 per cent. may be taken as an average; proteids are about 4.5 per cent., sugar 5.5 per cent., and ash 0.8 per cent. The total solids vary between 17 and 20 per cent., according to the breed of buffalo.

In the milk of the sheep, goat, and mare, there are wide differences in the percentage composition. Mare's milk contains small proportions of proteids and fat, but the percentage of sugar averages about 5.6, and in the goat 4. Sheep's milk exceeds 6 per cent. of proteid matter, and goat's has at least 5 per cent., while the fat content in both cases is high and may average 5 per cent. The total solids in the milk of the sheep, goat, and mare may be given as 17 per cent., 14 per cent., and 9 per cent., respectively. These figures are important, as will be seen when other subjects are discussed.

Casein and Albumen.—These are the flesh-forming parts of milk, or, as they are sometimes called, the nitrogenous compounds. Without casein, milk would not coagulate, for it is this substance that rennet acts quickly upon in producing curd. The thickening properties of milk may, however, be largely destroyed by heat, through decomposition of the lime salt. Casein is subject to marked changes by fermentation ; bitter and other objectionable flavours speedily follow the action of germ life. Albumen, which is found in milk in small quantities, is readily coagulated by heat, and forms a skin on the surface of milk. The milk of the Ayrshire and Shorthorn breeds is said to contain more casein in the albuminoid matter than is found in the milk of the Jersey, Guernsey, and other British breeds.

Sugar is a compound differing in composition from casein and albumen by the absence of nitrogen. Compared with common sugar it is less soluble in water, not so sweet to the taste, and is more easily converted into acid by bacteria. High temperatures quickly act on the sugar, giving to milk a cooked flavour.

There is a slightly higher percentage of sugar in the milk of the Ayrshire and Shorthorn breeds.

Analysis of milk and its products will be found on pp. 321-6.

Milking

Hand Practice.—In milking cows, the object of the milker should be to obtain the largest possible quantity of milk, without causing inconvenience or annoyance to the cow, or injury to her udder. It should also be borne in mind that care and consideration in milking develops in the animal qualities of the highest value. When this vitally important duty is neglected, the milking propensities of the cow may become so affected as to cause her to dry off many days before her usual period. Such a condition would not only entail an immediate monetary loss to the farmer, but the future of the cow as a profitable milker would be endangered. It might further be said, that the absence of care which is necessary to the development of the milking qualities of the cow would be reflected in her progeny, for it is fully recognised that improvements in milking stock have been materially assisted by strict adherence to the laws which govern successful milking.

Dry, Wet, or Moist Milking.—Diversity of opinion exists as to whether cows should be milked with wet or dry hands. Dry milking is a strong point with some teachers of dairying, but it is open to objection. It does not seem to be clear, however, what is meant by the term "dry milking." Assuming it implies that the hands must be kept dry, then it cannot be recognised as a safe operation, involving danger and injury to cows of a nervous and irritable temperament. It is known that milkers object to animals of the smaller breeds, owing to the shortness of their teats, and when difficulty arises in milking with the hands moistened, increased irritation to the cow must result from the "modern" dry practice. It might be asked, how many men and women can milk with dry hands with comfort to the cow, and profit to the owner? They are not numerous, and the training of young people in this practice would present serious difficulties. A further objection would be found in "stripping" the cow, and the writer doubts if the average dry milker would have sufficient activity left in the hands to complete milking in a thorough manner. The nearest approach to the action of the sucking of the calf is the most natural course to pursue, and which is most pleasing to the cow; but when animals resent their milker, owing to rough and imperfect manipulation of the teats, the cause must be removed. Further, the old practice of milking will be strengthened if we accept the theory that milk formation is going on in the udder of the cow at the time of milking.

Wet milking has been pronounced to be wrong, because of the universal neglect of milkers to adopt the necessary precautions to prevent contamination of the milk with dirt. But does not dry milking cause particles of dirt and scales from the teats and udder to fall into the milk? The habit of dipping the fingers in the pail, and having the hands dripping with milk, should be vigorously condemned by the farmer. Keeping the hands moist during milking is the most desirable course to follow, and with due attention to other features of cleanliness the milk should be free from foreign matter.

Blind Teats.—This subject should be brought prominently before milk suppliers. The number of cows suffering from blind teats is increasing. It is chiefly attributed to negligence in milking, and particularly in "drying off" the cow. Insufficient attention at this crucial stage causes an inflammatory condition of the upper part of the teat. After the attack is over, fusion of the tissues takes place, and a pellet-like body will be felt by the fingers, indicating that the passage in the teat has become closed.

There is practically no remedy for this defect, surgical interference being usually more hurtful than beneficial. The old and truthful saying, "Prevention is better than cure," is well illustrated here, and milkers are strongly advised to keep the teat passages open when the cow is drying off. In no case should this be overlooked. To maintain a healthy condition of the teats and quarters of the cow, the milker should balance the vessel, so to speak, by taking away from each quarter an equal quantity of milk. When it is observed that certain glands are more active, and the quarters appear to contain more milk at the outset of milking, the heavier quarters should be reduced to bring them into unison with the less active ones, after which the process of balancing the udder should be proceeded with. Hand-rubbing defective quarters is necessary to promote a healthy and vigorous condition of the glands. Stripping is a duty of special significance, and this should be strongly impressed upon every person engaged in dairy work.

Rules of Milking.—If milking were practised according to instructions, which are stringently pursued on some farms, there would be no dirt in the milk at a stage highly favourable to the development of taints. At dairies where the following rules are practised, the writer has made repeated examinations of the manufactured produce, and proof has been given of a high standard of quality: –

1. Milk the cows in a clean and sanitary place.
2. See that the milker is clean in person.
3. Brush the udder and flank of the cow.
4. Moisten the udder and flank with a cloth.
5. Wash the teats and dry them.
6. Moisten the hands at intervals with clean water while milking.

In dry warm weather, when the udders of cows are not discoloured with mud, washing is unnecessary. This is only to be resorted to when occasion demands, and the udder should be immediately dried to prevent chills and other mammary ailments. For milking, a seamless pail is recommended, and it should be rinsed with clean cold water before use. A sieve or strainer of hygienic construction, and easily cleansed, is indispensable.

A milking stool of the simplest design is preferred, and it should be cleansed in the same way, and as regularly as any appliance of the dairy.

Milking Machines

It is some twenty years ago since the milking machine was first brought under the notice of the public. The "Thistle," a Scotch make, was the earliest to be put on the market. Great improvements have been made of recent years, and the "Thistle" has been replaced by the Lawrence-Kennedy, Lawrence-Kennedy-Gillies or Vaccar, B.K.F., and Bartram machines. Since the principle underlying the construction of milking machines was introduced by the Scots inventors, dairying countries have given the subject serious consideration, with the result that altogether over twenty makes are now offered for sale, among which the following additional machines may be mentioned: Alfa-Ljungstrom, Alfa-Dalin Hartnett, Davies and Ransome, Gane, Jens Nielson, Klim, Lokvist, Max, Manus, Nyebae-Nissin, Omega, and Wallace.

There is a great future for power milking, particularly in countries like Australia and New Zealand, where large dairy farms are numerous, and labour in many districts scarce and uncertain. And to some extent the same may be said of the labour question in Britain, owing to the rapid depopulation of farm hands in rural districts. In the construction of the milking machine, inventors are now conversant with all that is required to make it a success, and the different trials that are now held in various parts of the world are to be thoroughly commended.

The real value of the milking machine will depend upon its simplicity of construction, durability of parts, efficiency in milking, influence on the cow, milking intensity, cleanliness and freedom of milk from bacterial contamination.

Let these very important elements be briefly considered.

Simplicity of Construction.—When this is combined with efficiency and other elements of importance, the machine has much in its favour. With no complicated parts, the working qualities are increased, less expense is incurred in upkeep, and costly supervision may be dispensed with. Machines of simple construction are usually light and easy to transport in the cowshed, and the price is more likely to be within the reach of the average dairy farmer.

Durability of Parts.—When undue strain is put upon the working parts through defective construction or mechanism, wear and tear of the machine is increased, and this may seriously reflect on its efficiency, as well as raise the cost of maintenance.

Efficiency in Milking.—A regular and easy flow of milk and clean stripping are qualities that should not be overlooked, although stripping by hand is always necessary. With high-class machines little milk should be left in the udder at the close of milking, and upon examination of the teats there should be no indication that the milk has been drawn under undue pressure or with injurious effects.

Influence on the Cow.—When the cow chews her cud and looks contented in every way, the machine is so far satisfactory. She does not attempt to keep up her milk, because the milking is gentle and feels natural. When the opposite is shown, the milking machine fails in its purpose, and unless the cause is removed it becomes a source of danger in the dairy.

Milking Intensity.—This is important. It means the weight of milk that is removed from each teat of the cow per minute, also the equality of the flow should be carefully considered.

Cleanliness.—When a machine is heavy of build, and has many parts, the question of cleanliness has to be seriously considered. Complicated types having much rubber tubing dangerously increase the difficulties of thorough cleansing. " Easy to clean " should be a factor of very great concern, and when dirty milk is attributed to difficulties in keeping the machine sanitary, it is robbed of much of its value as a profitable milker. Freedom of the milk from contamination with bacteria from other sources must not be lost sight of in estimating the practical value of the milking machine.

British Milking Trials.—In the 1913 trials of milking machines, conducted by the Royal Agricultural Society of England, the first and second places were won by the "Omega" and "Vaccar" machines. The former is the invention of a Swedish farmer near Stockholm, Mr Ivar Lindstrom, who after experimenting for many years perfected the "Omega," and in 1911 it was put on the market. As a modern invention the "Omega" fulfils the essentials already outlined, and a feature of considerable importance to small farmers is that the machine can be driven by ox or horse power.

The "Vaccar," which is the Lawrence-Kennedy-Gillies machine, is well known in Australia and New Zealand, where it is largely used. The owners claim that 12,000 of this type are in operation in different parts of the world.

Where power milking is adopted, farmers should insist on having competent employees to look after the machines. On no account should this fact be overlooked, because it would be not only unfair to mechanical milkers, but against the interests of those who employ them. When the milk is used for cheese-making it should be thoroughly aerated, which is necessary to perfect ripening of the milk and maturing of the cheese.

It is the intention of the writer to prepare a special booklet on the subject of milking machines. The question of cleanliness will be specially considered.

Deterioration of Milk and Cream

It is a noteworthy fact that the condition of the atmosphere—not necessarily a high temperature—determines the keeping qualities of milk and its products. In cold winter weather, if the temperature of a room is raised to 80° F. for a couple of days, and then fresh milk and cream are exposed to the atmospheric conditions, acidity is slow to develop. Why should this be, when in the summer months, at a much lower temperature, and in a few hours, it becomes sour, the rapidity being in some instances astonishing? It is not because the milk or cream is more free from bacteria than the summer supply: it is because the bacteria are less active in the colder months of the year. The danger that is wrought when the air is humid, and especially during thundery weather, is excessive. A moist and sultry atmosphere increases the activity of micro-organisms. We cannot alter the climate to prevent danger to produce, but we can adopt preventive means, as the following rules explain:—

How to Prevent Bad Flavours—

1. Cleanliness in milking.
2. Cleanliness of milking-yards.
3. Thorough cleanliness of the utensils used for milk.
4. Thorough cleanliness of the room or place where the milk or cream is stored.
5. Freedom from objectionable smells in and around the dairy.
6. A pure water supply.
7. Care in feeding.

Rule 1.—Let the advice already given be repeated. Milk the cow after her udder and flank have been moistened with a clean cloth. Milk after the teats have been washed. Milk after the hands and clothes are clean. Milk in a clean place, and into a vessel that has been washed and scalded. In carrying out these recommendations there is practically no additional cost to the producer. Little or no extra time would be required, compared with the common and objectionable practices of to-day. A boy would precede the milkers, and attend to the cleaning of the udder and teats. Such a provision would leave the milkers free to do the milking only, thus avoiding as much of the dirty work as possible. The same boy would provide water for the milkers to wash their hands after finishing each cow, also a clean supply for moistening the hands during milking. The writer would also suggest that those engaged in milking should be provided with overalls, to be put on immediately before milking is commenced, and taken off immediately it is over. Let the young people on the farm be taught the value of care and cleanliness in milking, and as they grow up the knowledge gained will enable them to appreciate and understand the true value of this vital part of the dairyman's duties.

Rule 2.—Cleanliness of Milking-Yards.—Some farmers wonder why so much has been said about this part of dairy instruction. It is because taints in produce have been traced to insanitary practices. The writer's attention was once drawn to a very peculiar flavour in cream and butter. Scientific examination of the affected produce was made, and it was ascertained that the injury to the cream was the work of a particular germ. While the bacteriological investigation was being pursued, inquiries were made at the source of the cream supply, when it was discovered that the uncleanly condition of the ground where the milk was stored was responsible for the hurtful flavour. As soon as this was explained to the farmer, he put everything in a satisfactory order, and no further trouble was experienced. Many illustrations of a similar kind could be given, but the above is sufficient to show the dangers that result from want of simple precautionary measures at the farm. To reduce the risks of contamination, and to make the milking yards pleasing to the eye, the milking sheds should be periodically treated with lime wash, and kept thoroughly sanitary.

Rule 3.—Thorough Cleanliness of the Utensils Used for Milk.—This is another duty which requires very great care. If this is not attended to, hurtful organisms will lodge in the vessels, and when a supply of fresh milk or cream is added it is at once attacked, and bad flavours immediately develop in the product. In sterilising dairy appliances one cannot be too free in the application of boiling water and soda. This should always be used, but only after the vessels have been washed scrupulously clean. The soda solution not only attacks living germs, but it helps to prevent the utensils from rusting. Great precautions should be taken to cleanse milk strainers and the seams of all vessels. Exposure to the air, and if possible, sunlight is invaluable after the sterilising has been done. Immediately before use, the vessels should be bathed or rinsed with clean cold water. Applications of lime water to utensils are strongly recommended.

Rule 4.—*Thorough Cleanliness of the Room or Place where the Milk or Cream is Stored.*—It is absolutely necessary to use storage rooms for one purpose only. If this is disregarded, and dairy produce is kept with vegetables, meat, harness, clothing, etc., odours will taint the atmosphere, and injure the perishable produce. The walls of the dairy should be treated with lime wash at least every four months, and good ventilation provided at all times. In hot climates a wire gauze over the windows, and a gauze inside door, will be found very profitable. This will admit a free circulation of air, also prevent the entrance of flies and other insects.

Rule 5.—*Freedom from Objectionable Smells in and around the Dairy.*—Bad smells are quickly acquired by milk and cream, owing to the high absorbing power of these raw products. This can be proved by placing a vessel of milk or cream in a room in which the odour of turpentine, kerosene, onions, or any strong-smelling substance is present. In the course of a few hours the produce will taste of the contaminated air.

Rule 6.—*A Pure Water Supply.*—To avoid danger to the milk supply it is necessary to provide clean drinking water to the cows, and to have the troughs situated at a convenient distance to where they are grazing. If this is not done, the cows will deny themselves their requirements of water, and this will cause injury to their milking qualities, and encourage disease.

Rule 7.—Care in Feeding.—The writer's experience in different countries has shown that attention is required to reduce the growth of objectionable weeds, and where possible to eradicate them from the land. Unwelcome plants grow over large areas in Australia, Africa, and other countries, and their bad influence is felt by stock-owners as well as dairy farmers. Where the wild mustard, cress, and turnip flourish the injury to the flavour of dairy produce is considerable. In attacking the weeds it is preferable to select the smallest paddock on the dairy farm to commence operations. Where there is a good natural pasture, attention in such a case would be directed to the destruction of the flowering heads and stems, thereby preventing the spread of the matured seeds, which, if left undisturbed, would give rise to fresh plants on other parts of the farm. With cultivated crops, such as lucerne, rape, and cabbage, trouble frequently arises, but there is no reason why the milk should be tainted when ordinary precautions are taken. Lucerne and rape should be given to cows in moderation, and when lucerne is fed immediately after cutting it is recommended to mix it with dry fodder. In feeding cabbages, the writer would draw the attention of suppliers to the possibilities of a bad flavour in the milk arising from the use of the stems, and to avoid risk, would suggest giving this food, as well as others of a taint-producing character already mentioned, only after the cows are milked. The farmer's discretion is also required in the feeding of silage to dairy stock, and under no conditions should cows receive vegetable matter that has decomposed.

Pasteurisation of Milk

Pasteurisation is a process of heating liquids which derived its name from the great French scientist, Pasteur, who was the first to discover the death-dealing action of heat on micro-organisms in liquids. Pasteurisation is frequently confounded with sterilisation, which claims to completely destroy bacteria by the action of high temperatures. In some instances heat is required much beyond the boiling point of water before germ spores are killed. Some organisms can withstand a temperature exceeding 300° F., and others are active for months at temperatures below freezing point. Fortunately, the majority of pathogenic or disease-causing germs are of the common non-spore making class, and offer little resistance to heat.

When milk is raised above boiling point for thirty minutes it is termed sterilised; but sterilisation has a detrimental effect upon the milk solids, decomposing the sugar, coagulating the albumen, partially decomposing the casein, and rendering insoluble the lime salts. Sterilisation and pasteurisation can be done upon the intermittent process; lowering and raising the temperatures afford the ferments an opportunity of developing, followed by death at their weakest moments.

It is generally believed that scalding and rapid cooling is all that is necessary to destroy bacteria, and ensure for the milk a high keeping property. Pasteurising and slow cooling will give to milk increased preservation, as the following test will show.

Fifty gallons of mixed milk were pasteurised at a temperature of 160° F. One half of this quantity was immediately refrigerated to 40° F., and passed into 15-gallon churns. The other half was conveyed direct from the pasteuriser into two churns of similar capacity, which were standing in a vat of chilled water. The lids were put on the four cans, and twelve hours after the milk was pasteurised, tests for acidity were made. The refrigerated milk showed a higher degree of acid, and a lower degree of bacterial purity. Further examinations proved conclusively that the unrefrigerated milk possessed higher keeping qualities. The writer attributes this to the cooking to death of the bacteria, and by the suffocation, so to speak, of the aerobic germs through the absence of air. Where the milk is pasteurised and immediately afterwards refrigerated, the heat is not sufficient to destroy the bacteria, and the cooling process provides air for the multiplication of the organisms that survive the scald.

Milk pasteurised and cooled in the cans for household purposes has not a cooked taste, as one might expect. Further reference will be made to this subject in explaining the aeration of milk for cheese-making, also in the scalding of milk by consumers for dietetic purposes.

Nothing is more urgent in connection with the food of a nation than the purity and wholesomeness of the milk that enters so largely into the diet of the young and old, rich and poor. The cry is for a pure and healthy supply, and efforts are now being made in the cities of the Empire to reform the industry. Who is to blame for an unclean milk supply of any country, city, or town? Is it the farmer, the retailer, the consumer, or all of them? Upon each, rest responsibilities, but the State is the guardian of the public in food supplies. Year in and year out one reads of the danger of impure milk, of the fading confidence of the consumer in his supply, but in many countries a poor effort has been made to give the public a feeling of real safety in the milk upon which the lives of children and sick so much depend. In Britain, with her boasted laws of civilisation, her great seats of learning, and commercial status, little has been accomplished to put the milk supply upon a healthy basis. And it is only recently that the use of chemicals (poisons) to preserve milk was made prohibitive in England. It is perhaps well for England that the death-roll among infants and the young, through the indiscriminate use of preservatives, cannot be estimated. Great as this loss has been, there are others to be considered. State negligence of the interests of the dairy farmer has inflicted upon him severe penalties, to the gain of foreign imports.

The condensed milk business, for example, flourishes in England, but the raw material does not come from the British cow : condensed milk is imported principally from Continental countries, where rigid laws have been enforced by Governments to raise the purity and general quality of the milk from which the condensed article is made. Those who have travelled in Switzerland cannot fail to observe the power the State exercises over the milk supply, and for what reasons, might we ask? Firstly, because experience has proved that an ounce of tainted milk would ruin a whole making of the condensed product, with the inevitable result that the industry would suffer if the State neglected to guard the interests of the producer; and, secondly, England, with her fine lands and ideal conditions for dairying, is one of Switzerland's best patrons. To retain her confidence in the virtues of condensed milk is only by the vigilance of the Swiss Government in keeping the supply pure and wholesome. British consumers of milk are indebted to Switzerland, and no one has higher praise than the writer for the dairying industry of that splendid little country.

Milk and Disease

This subject is receiving a good deal of attention at present, and perhaps one is correct in saying that no more important question affecting the health of people calls for the consideration of all parties. The milk supply should be put on a footing that will restore the implicit faith of the public in the purity and value of the product as an indispensable article of food.

Having had occasion to make a study of milk problems in different countries, and having been privileged to conduct a number of official investigations connected with the milk supply, the writer will give a frank opinion on some phases of milk and its relationship to disease. It must be admitted that milk is a medium for the conveyance of tuberculosis to man, and the danger is increased when cows suffer from the disease in the mammary organs. Fortunately, the percentage of such cases is not large, and the possibilities of milk becoming infected with tubercle bacilli when the udder is healthy need not cause anxiety.

Experience has shown that the contamination of milk with pathogenic bacteria, including the tubercle bacilli, can be traced to the carelessness of milk consumers, as well as to unhealthy cows. Writing as above, there is no desire in the slightest to detract from the dangers which surround the milk cow—they are already known to the writer; but too much is made of this source, which acts as a deterrent to efforts in other directions for the prevention and suppression of the disease in man.

If an inquiry were conducted into the way milk is kept and treated by the average householder, startling revelations would follow. No one dare dispute the fact that this product is kept in jugs and receptacles that are, bacteriologically speaking, breeding grounds for microbes, and the placing of these vessels outside the doors of householders at night-time to receive the morning milk is to be regretted. In addition to this danger, open vessels containing the household supply are too frequently "stored" in insanitary rooms, sick chambers, and in unhealthy cupboards. With tuberculosis or other diseases in the home, is there not grave risks to health through this carelessness? It might reasonably be suggested that the compulsory notification of tuberculosis, with its attendant reforms, and a campaign on householders to draw attention to their own responsibilities, would help to reduce mortality from tubercular disease communicable through the milk supply.

Pasteurisation and sterilisation of milk are adopted against the spread of tubercular disease, and many believe this is sufficient to absolutely destroy all danger. Pasteurisation is a valuable protective measure, and striking evidence of its worth is to be found in different cities of the world, but it must be admitted that pasteurisation will not remedy the chief evils of the milk supply. It is quite possible that the persistent advocacy of the practice has exercised a feeling of comfort and safety in the milk trade and amongst consumers that has been put to abuse. In other words, pasteurisation and sterilisation of milk are terms so acceptable as to be used as a cloak to hide insanitary practices, and to retard much needed reforms. It is reasonable to believe this will continue in all cities until a sound system of inspection of dairies becomes compulsory by Act of Parliament. Although the writer is a supporter of pasteurisation under common-sense conditions, it is known that the application of heat reduces the health-giving and digestive properties of milk, and heated milk that has become stale is positively dangerous to the consumer, while raw, clean milk, with its varying percentages of lactic acid, possesses valuable medicinal properties. This comparison is merely made to show the urgency for attacking the bed-rock evils of the milk supply. The writer's studies and observations in the Near East, where acid milk is the national drink of Bulgarians, and so much prized by Balkan races, proved the tremendous claim healthy raw milk has over the pasteurised product. But in large cities abroad, and where the summer heat is extreme, and the deterioration of milk hastened, pasteurisation is indispensable, and the same will apply to cities in Britain, particularly in the warm months of the year. From experience of the subject, and having a pure and healthy milk supply in view, the following measures are recommended : —

(*a*) The eradication of cows affected with tuberculosis of the udder, with compensation to owners. (A regulation on these lines has become law in Britain.)

(*b*) The licensing of farms, dairies, milk shops, and restaurants, and their compulsory inspection by thoroughly qualified Government Dairy Inspectors, who would act as advisers and instructors, as well as enforce the regulations of a sound, practical Act of Parliament.

(*c*) The establishing of State depots in cities for the supply of pasteurised and certified milk.

(*d*) Instruction in schools on the subject of milk and its products.

Where Reforms are Necessary

To establish the milk supply on a sound and satisfactory basis, it is imperative to correct its source, and to eliminate dangers that exist after the product leaves the hands of the farmer. To say that machinery and scientific practices will give the desired result is a remedy in disguise.

Defects in milk may correctly be brought under two classes, namely, those beyond the farmer's control, and those over which he has control. Let us deal with the former under the following headings :—

1. Defective State education.
2. Want of encouragement to farmers.
3. Faulty dairy buildings.
4. Unsuitable sites.
5. Bad equipment.
6. Want of capital.
7. Defective cans and transport dangers.
8. Carelessness of householders.
9. Restaurant dangers.
10. Injurious permanent water supply.
11. Faults in the retailing and storage of milk.

1. *Defective State Education.* —This subject will be considered in another chapter; meantime let it be said

that the milk supply of any country will not be remodelled and made satisfactory by an Act of Parliament that indirectly bestows the administration upon the medical and veterinary professions. Through an error of this kind the dairy farmer will find himself under the inevitable heel of compulsion, with its dreaded displeasures and annoyances.

2. *Want of Encouragement.*—Perhaps the writer is correct in saying that no business receives less encouragement from the community than the business of the dairy farm. The public pay only one price for household milk, and for butter, cheese, and other foods they pay on a basis of quality. It therefore follows that the milk producer is not in the least encouraged to raise the quality and purity of his supply.

3. *Faulty Buildings.*—Defective construction and bad ventilation of buildings greatly increase the dangers of milk contamination, also the labour of the farm is made more irksome and unattractive. As few farmers in Britain own their holdings, it should be compulsory for the landlord to put all buildings in a thoroughly sanitary and healthy condition, and they should be convenient in every respect for the responsible work of the dairy.

4. *Unsuitable Sites.*—Bad situation of buildings in quite a number of cases is responsible for sanitary defects, and they increase the difficulties of a healthy milk production.

5. *Bad Equipment.*—There is what might be termed the landlord and tenants' equipment, the former being fixtures. Frequently the landlord's responsibilities have to be made good by the farmer, which ought not to be.

6. *Want of Capital.*—The absence of State banks prevents enterprising and intelligent men from effecting improvements in the equipment of their farms, and adopting modern practices essential to success. From experience of this invaluable aid to dairy farming the

writer can say that its introduction in England, or any dairying country, on a practical and thoroughly helpful basis, would stimulate the industry, and remove from many deserving farmers the barrier that separates them from the goal of their business lives.

7. *Defective Cans and Transport Dangers.*—Contractors for milk should be compelled to provide seamless churns, and to keep them in thorough repair for the conveyance of milk; also the cans should be effectively sealed, and under careful Government inspection.

8. *Carelessness of Householders.*—On this subject readers are referred to "Milk and Disease" on pp. 17-20.

9. *Restaurant Dangers.*—Milk in considerable quantity is retailed by restaurants at railway stations, and other centres in Britain. Strange to say, the retailer would appear to be at liberty to adulterate the milk and to treat it to his satisfaction. He may sell the product at fictitious prices, withholding any guarantee of quality or purity whatever. Infants and children are undoubtedly the largest consumers of this milk, and, might the writer ask, are these restaurants not responsible for the spread of disease through the milk supply? A rigid inspection of restaurants is no doubt very necessary.

10. *Injurious Permanent Water Supply.*—Impure water for drinking purposes will reduce the keeping properties of milk considerably. Cows depastured on sewage lands are proof of this. The water supply is of vital importance.

11. *Faults in the Retailing and Storing of Milk.*—The handling of milk by wholesale and retail depots is subject to criticism, and the law should be severe in placing this branch of the milk trade on a secure basis.

The storage of milk is a feature of our subject which necessitates strict attention, and if not carried out in accordance with the demands of science and practice, serious results may follow. What is not quickly disposed of by the milk depot from fresh deliveries should be pasteurised in the hot weather and stored in a hygienic cool room. In the winter months this may not be necessary, but on no account should milk be kept in cool storage until acid is perceptible. When milk of this quality is retailed, deterioration is very rapid, and it becomes a dangerous product to health.

Questions affecting the Quality and Purity of Milk over which the Farmer has Control :—

1. Breed of cow.
2. Individuality.
3. Period of lactation.
4. Health.
5. Treatment.
6. Feeding.
7. Condition of dairy buildings.
8. Treatment of utensils.
9. General cleanliness.
10. Aeration of milk.

1. *Breed of Cow.*—The breed of cow greatly influences the quality and quantity of milk, and the dairy farmer should receive advice and guidance on this very important subject. If milk were sold on its fat percentage, encouragement would be given to dairy farmers to keep breeds which give milk rich in fat, and the increased price per gallon would balance the smaller yield.

2. *Individuality.*—Different animals of the same breed give different quantities and qualities of milk, due chiefly to the temperament of the cow. Farmers ought to be taught how to test the milk of each cow for fat by a simple method, and to keep records to determine the profitable from the unprofitable cows, and to guard against any yield that might fall below the legal standard.

3. *Period of Lactation.*—Milk from cows just after calving contains an abnormal amount of albumen, which is highly putrefactive, and gives to the milk a bad taste. Such milk should not be mixed with the general supply

until it is normal, which takes from a week to a fortnight after parturition.

4. *Health of the Cow.* Ailments, especially of the udder, influence the milk yield. Cows found to suffer from tuberculosis of the udder should be destroyed, and compensation paid to the owner. Periodic inspection by a veterinary surgeon is recommended.

5. *Treatment of the Cow.*—Ill-treatment of cows before or during milking has a disastrous effect on the milk yield.

6. *Feeding.*—Cows should be supplied with a properly balanced ration. Many cows with good milking qualities convert all digestible food into milk at the expense of their vitality, which weakens the constitution, causing ailments. It has been shown that certain plant foods cause objectionable and injurious flavours in milk, and these should be given with care.

7. *Condition of Dairy Buildings.* Dairy buildings should have a healthy atmosphere, be well drained, and kept in a clean and sanitary condition. Lime wash should be used as directed in this book. It is not advisable to sweep or disturb the cow-shed before milking, as particles of straw, dirt, and dust will contaminate the air, and endanger the milk supply. A clean, pure atmosphere at all times is of vital importance.

8, 9. *Treatment of Utensils and General Cleanliness.*—These have already been detailed.

10. *Aeration.*—Immediately after milking the milk should be taken from the cow-shed and passed over a cooler, which every farmer should be provided with. This practice eliminates disagreeable flavours from the milk, which, if not removed quickly after milking, cannot be done successfully at a later stage. Great care must be taken to ensure a pure atmosphere at this operation. At the premises of the contractor the churns should be washed with a solution containing soda, and then sterilised by live steam before being returned to the farmer.

We now come to deal with the milk on arrival at the city depot. Each can should be sampled for flavour by an expert taster. Samples should be taken for fat and bacteriological examination. If the milk passes the necessary preliminary examination for flavour, it should be divided into its respective quantities for sale, either as a pasteurised product or as raw milk. If for pasteurising, the milk should be raised to a temperature of 160 F. for a few minutes, and then allowed to cool slowly, and finally chilled to the necessary degree. It should then be bottled and sealed automatically. In this way it is delivered to customers, who should decant the milk from the original bottle for household purposes, this being made possible by the use of duplicate bottles supplied by the dairy. To prevent the milk being pasteurised or scalded a second time at the home of the consumer, to the detriment of its nutritive properties, every bottle should bear the description, "Pasteurised Whole Milk," in clear lettering.

An Ideal Milk Supply

After every phase of the subject has been reviewed, one is attracted to farms where production and retail are conducted under the same roof, so to speak. These fortunate cases, however, are not common ; they are very much in the minority, and the application of the system cannot be applied universally. On a farm of this kind the farmer controls every department, from the feeding of the cow to the delivery of the milk into the hands of the consumer. The process is briefly as follows :—

After careful milking, the product is run through a sieve containing cotton wool, which removes any foreign matter that might be present, but it must be remembered the bacteria are not withheld by the filter. It is a case of what the eye does not see the heart will not grieve over. It is then taken to the adjoining building, and aerated and chilled in a pure atmosphere, the artificial cold being supplied by a power refrigerator. A temperature of about 40° F is obtained in a few seconds, as the film of milk that passes over the cooler is very thin. From the cooler the milk is automatically discharged into sterilised milk bottles which have various capacities, according to market requirements. The bottles are carefully sealed, and the product is retailed in this way. When everything is properly done the milk has a better keeping quality, only there is an element of danger with careless people who think the introduction of the cotton-wool sieve and the refrigerator will obviate ordinary precautions in milking and other duties of the dairy. A good system of official dairy inspection, however, will prevent abuses that might arise, and the full benefits from modern appliances and scientific methods will then be obtained.

Purchase and Sale of Milk

The general practice in the milk trade is to supply the product to the city shops and depots direct from the country. This increases the dangers of deterioration of the milk, and causes difficulties to both buyer and seller. These, however, can be overcome.

In all large milk depots on the Continent milk tasters are engaged. Their duty is to taste each supply, and if a foreign flavour or odour is detected the milk is rejected. Samples are also taken for chemical and bacteriological examination. The centrifuge and the cotton filter determine the amount of sediment in the milk, which is a very important step in deciding its purity. The use of preservatives in milk is absolutely prohibitive in most cities. This was not always the case. The writer can remember, when he went to Queensland, milk preservatives were sold by grocers for use by the general public, also by butter and cheese factories for the preservation of the farmers' supplies of milk and cream. One can imagine the injury that was being done to the health of the people, and the damage to butter and cheese, by the indiscriminate sale of the "innocent" poisons. Happily this is a thing of the past in that State. City milk depots should protect themselves against inferior supplies of milk by a written contract with the farmers, stipulating that the milk must exceed a certain standard of fat, and be free from any traces of taint or objectionable odour. It should pass the filter test and other examinations for purity that may be decided upon by the purchaser. The award for fat might be calculated on the number of degrees above a minimum percentage, 3.2.

Two prices would be paid for the milk, both radiating, so to speak, from a 3.6 fat test. Arrangements could be made to provide the supplier with a weekly statement of the general quality of his milk, and the number of tests and examinations to be done by the purchaser would be at his discretion. A system of this kind would not only encourage farmers to raise the fat standard of their milk supply, but it would decide its purity.

In reviewing the writer's suggestion, the wholesale milk buyer might look upon testing as intricate, difficult, and impracticable. This view would be absolutely wrong, for there is nothing in the fat testing, centrifuging, and filtering of samples to prevent the man of ordinary intelligence from doing it correctly. One simple machine, either driven by hand, steam, or water power, will do both the fat testing and centrifuging. Intricate tests would not be necessary except in special cases, and this work would come under the care of the veterinary or medical officer, and not the milk contractor. It must be admitted that, whatever objections are raised, a uniform system of buying milk on quality is necessary.

When we look at the present unhappy position of the milk supply, we cannot fail to see that it bristles with temptations, dangers, and injustices, and these are borne in turn by the farmer, milk salesman, and consumer. And with what result? The whole industry is developing on wrong lines, and the public are in a dilemma as to the safety of the milk supply. We have a costly system of education, which, among other things, aims at instructing the farmer how to improve his breed, and raise the fat percentage of the milk. On the other hand, we have a fat standard of 3 per cent., which, as the law at present stands, indirectly invites the farmer to tone down the milk to a safety limit, say 3.2. It might be asked, is the farmer legally and justly entitled to act in this way? Certainly he is, for the good reason, he receives in average cases no more from the milk contractor for rich, pure milk than he gets for the watery product. And the contractor will tell you the crux of the whole trouble is with the consumer, who will pay only one price for milk, although other commodities of minor importance to the health of the household are bought on a quality basis. This is where the State should step in, if only to protect the people against themselves. It is another instance of what the writer has maintained in this book, that dairy education without legislation is robbed of its true value. Legislation will purify the source of the stream. Education, unsupported by legislation, begins with the current and races with it to the outlet. At present the law punishes where it ought to teach. It demands a standard of fat, but the milk need not be pure and healthy. The toning of rich milk with a diluent is a practice surrounded with grave dangers, and it will continue until reforms, as suggested here, are put into operation. Justice and honesty will then be instilled into the whole milk business.

The writer will put forward another suggestion in the sale of milk to the public. Three grades could be instituted, as follows:—

(*a*) "Standard Milk," or in other words, not below 3.2 per cent. of butter fat, and guaranteed bacteriologically and chemically pure.

(*b*) "First Quality," with not less than 3.5 per cent. of butter fat, and guaranteed bacteriologically and chemically pure.

(*c*) "Special Milk," with over 3.8 per cent. butter fat, and guaranteed bacteriologically and chemically pure.

The prices of the milk could be fixed by the trade twice yearly.

Certified Milk.—If Government inspection was effectively carried out the supply of milk from certain districts might be certified as satisfactory. City depots for the sale of this class of milk, also pasteurised milk, should be instituted, if only in the interests of those who are too poor to purchase clean, nourishing milk for the sustenance of their children.

Sanitary Milk Tests.—County agricultural and dairy associations should institute milk competitions for dairy farmers. They should be invited to send samples of milk and cream to a central laboratory, accompanied by a printed schedule giving the most important particulars concerning the samples. Sterilised corked bottles and the schedules would be supplied by the association, and prizes offered for the purest and best samples of milk and cream. Reports would be drawn up detailing in a practical way the nutritive standard of the products, the percentage of foreign matter found, and the bacterial purity. Apart from the interest these tests would create, their educational value would be considerable. In countries where dairying is a big industry, bacteriological examinations of cream are made to determine its value for butter-making. The cream need not be sweet or fresh for this purpose. This class of work is important in educating the farmer and factory manager in vital questions of the dairy.

A Grave Error.—The farm filter in many instances is shrouded in danger. It is a serious mistake to conduct dairying under the belief that milk can be "cleansed" by the use of an appliance that is guaranteed to keep back the finest particles of foreign matter. It is not the little bits of straw and grains of earth that do the damage, it is the germs that accompany every particle. What becomes of them when the milk is contaminated with dirt? They enjoy liberation, and only the cleansed dirt is withheld by the filter. Keep out dirt by cleanliness, and use the filter as a precaution against accidents.

Graduated Hygienic Milk Jug

We have already thrown a share of the responsibility on the shoulders of the consumer for not exercising precautions to reduce the risks of milk becoming contaminated with germ life. The commendable practice of delivering milk in graduated bottles is not likely to become universal in small towns and villages for years to come, and the time is not yet ripe to make this innovation compulsory by law. It is obvious that the present system of taking delivery of milk in jugs will have numerous supporters for various reasons.

The necessity for a milk jug constructed on an approved principle, and fulfilling the requirements of the householder, has appealed to the writer. The one designed should obviate some of the dangers of the present system of keeping milk and cream in all sorts of vessels and under unfavourable conditions of temperature and storage.

Provided with a graduated milk jug, manufactured from stout glass and designed as illustrated, householders will be able to check their purchases, and the following additional advantages will be obtained. The slightest defects in cleansing will be quickly observed. There will be no refuge places for dirt, and no absorption will take place, which is a dangerous feature of many jugs. The adjustable metal handle will save expense, caused by breakages so common to jugs with fixed glass handles.

When the jug is used in conjunction with the scalding apparatus and cooler, consumers should have at their disposal a very simple, inexpensive, and effective outfit

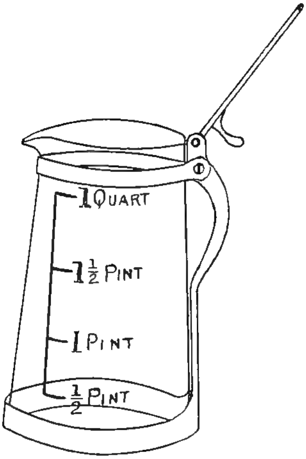


Fig. 1.

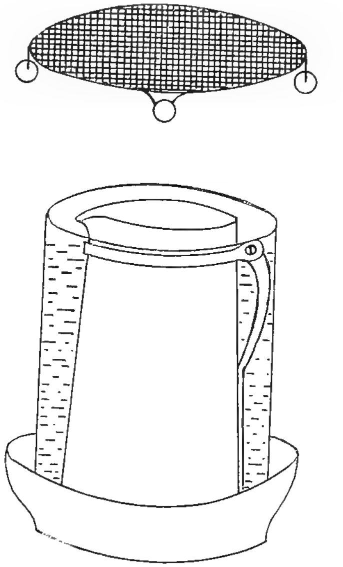


Fig. 2.

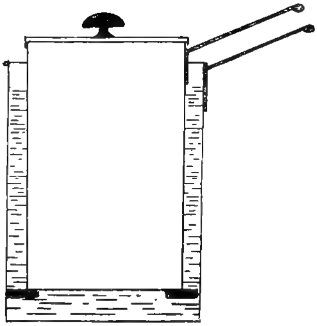


Fig. 3.

1. Thomson's Graduated Milk Jug, with Adjustable Handle and Lid.
2. Showing Jug immersed in water contained in Canvas Cooler, with Net Cover for use to prevent Contamination of the Milk by Insects, etc.
3. Appliance for Scalding Milk.

for the preservation of milk. Milk souring in the home should be a thing of the past, and the very dangerous practice of adding alleged harmless preservatives to the milk in hot weather dispensed with. Further, the scalding of milk that has been previously heated and cooled by the wholesale or retail milk-seller, with its dangers to the health of the young, will also be obviated. This is a question that should not be overlooked.

Scalding and Cooling the Household Supply.—When milk is scalded a jacketed pan should be used, which provides a circulation of water around the inside vessel. This will permit of the milk being raised to a higher temperature without causing an unpleasant taste. To obtain the greatest advantage from the use of the pan shown in the illustration, add the milk to the inner vessel, replacing the lid, afterwards fill the jacket with water, and boil for a few minutes. Put the inside vessel into cold water, and after ten minutes take the lid off, and pour the milk into the hygienic jug. Pour from one vessel to the other several times to bring the milk into contact with a pure atmosphere. By this treatment coagulation of the albumen will be prevented on the surface of the milk, and the good flavour will be better retained. If milk can be preserved without the action of heat, it is a more valuable food for the consumer. The attention of readers has already been drawn to this fact, and the refrigerator is shown to be of the utmost value in filling the want. But it cannot be transported to the homes of the public. We must, therefore, look for something simple, inexpensive, and practicable. In conjunction with the glass milk jug, a stout water bag, a little higher and a few inches wider, is used. The water bag is provided with a metal collar, and a metal band down the side to keep it rigid, and it is placed in an earthenware saucer. In the water contained in the bag the jug of milk is immersed. Evaporation of the water will quickly take place in hot weather, which will cause the temperature of the milk to fall. The best results are obtained when the bag with its contents are placed in a draught.

Cooling the Dairy

In warm climates there is difficulty in keeping the dairy cool. Factories can be provided with refrigeration at a low cost, but the average dairyman cannot afford to use machinery of that sort, and he will be pleased with a cheaper substitute. Buildings as shown in the illustration have been used by several Australian dairymen for many years.

The knowledge that the earth's temperature at about 12 ft. below the surface is maintained at about 60° F. in most places is valuable to many people, especially to dairymen; but in order to secure a draught of cool air into an over-surface room there must be a considerable area of underground tunnelling. In the illustration the butter room is built with double walls of tongued and grooved boards. The space between the walls should be filled with charcoal or cocky chaff. The flooring boards should not reach to the walls by about an inch all round, and the skirting boards should be slanting inwards at the bottom, and scolloped at the top so as to facilitate the passage of air from the tunnel. The tunnel should lead into

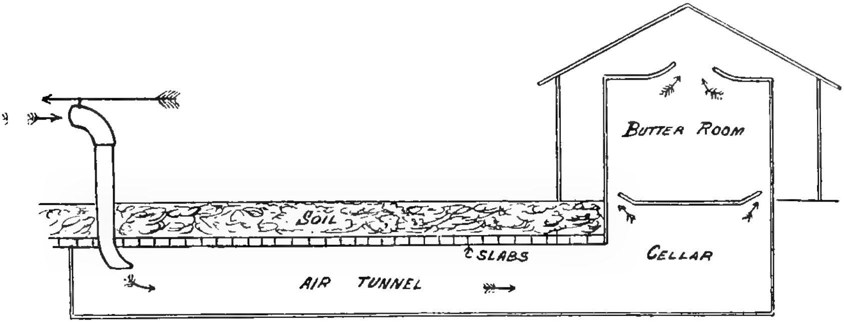


Fig. 4.

a cellar beneath the butter room, and may be 5 ft. or 6 ft. high and 2 ft. to 3 ft. wide, with a length of not less than 60 ft., the longer the better. Between the top of the tunnel and the surface of the earth there should be a depth of at least 4 ft. of soil. The top or roof of the tunnel may be covered with slabs, or slates, or any substance that will keep out the soil, etc., and at the outer end of the tunnel there should be a pipe, say 8 in. diameter, leading to the outside air. This should be fitted with a cowl and vane to face every breeze that blows, and to carry the air down into the tunnel, and thence to the cellar and the produce room.

Value of Foliage.—Where milk, cream, and butter rooms are exposed to high temperatures, it is recommended to erect a cheap lattice frame, three or four feet from the walls, and extending to the height of the roof.

Creeping plants of robust constitution, having large green leaves, should be planted, and the dense foliage, as it covers the lattice or trellis work, acts as a splendid protection against the sun's rays and heated atmosphere. The space between the thin dense hedge and the walls is kept cool, which corresponds with the air-space of a refrigerated chamber.

Where cream rooms are partly underground, and the walls protected with plant growth as recommended, a much lower temperature is maintained, but provision for proper light and ventilation is essential. Where this is not arranged, the atmosphere becomes impregnated with odours which act harmfully on the produce. In many cases it would be still more effective to erect over the whole building lattice framework for the growth of the creepers, thus shading the roof as well as the walls. The erection of rough but strongly built shelter-sheds and huts grown over with foliage in districts where cream is collected by carts sent round by the factories, would also be attended with good results. The prevailing custom in parts of the Colonies is to leave cream supplies at the roadside until removed by the collecting waggon.

A Simple Cooler.—Overhead erect a water tank, attached to which is an iron pipe—preferably gun-metal—perforated with small holes situated at short distances from each other. Underneath is a plain wooden stand, on which the cans are placed. The cans are of the ordinary shape, and have a specially constructed lid with a tube on the top 8 in. long, through which passes the handle of the stirrer. On the cans there are stout covers, made so as to be easily removed. The water is regulated so as to keep the cans continually moist. The accompanying diagram illustrates the process of cooling.

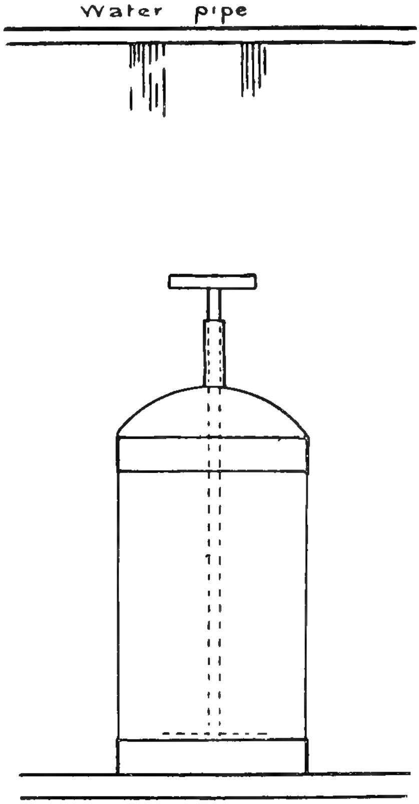


FIG. 5.—Milk and Cream Cooler (Thomson).

To prove the efficiency of the cooler, the following reduced temperatures were obtained by a dairyman, who has been most successful in the application of the system :—

TEMPERATURES OF CREAM AND SKIM MILK

Temperature of Air in the Shade at 95° F.	Before Cooling.	After Cooling.			
	11 A.M.	2 P.M.	5 P.M.	8 P.M.	6 A.M. next Morning.
Cream—No. 1 can, full	82	74	68	67	61
No. 2 can, full	82	75	66	66	60
No. 3 can, full	80	74	67	66	60
No. 4 can, half full	84	75	68	66	59
Skim milk, full -	84	76	70	69	...
Water used - -	70	72	78	78	68

The average fall in temperature of the five cans was 22°. The enterprising farmer informed the writer that had the day been warmer than 95° the temperature of the cream would have been lower; but on no occasion was he compelled to churn the ripe cream at a higher temperature than 58° F. Milk and cream suppliers will find the cost of erection of this cooler trifling, all that is necessary in the shape of a building being low walls of skeleton woodwork covered with canvas. A feature of the system is its adaptability to the treatment of small supplies, as well as of a large number of cans. When it cannot be adopted in the preservation of milk, let other practices be tried. A simple device consists of a circular stand of shelves, over which is a canvas cover, the top part being submerged in a receptacle of lime water. By this method a constant circulation and evaporation of water goes on day and night. The higher the temperature the more moisture is given off, and this extracts the heat from inside the stand, thereby cooling the stored produce and retarding fermentation.

Value of Lime to Dairying

Every branch of dairying and dairy farming has a special interest in the virtues of lime. The farmer recognises its usefulness in the improvement of his pastures and in the cultivation of leguminous crops, such as clovers, lucerne, vetches, and sainfoin. His experience has shown that lime sweetens the soil, and improves the nutritive properties of crops. But lime has another great use. It is a germicide that is inseparable from the dairying industry. When in Denmark the writer was impressed with the perfect cleanliness of many of the dairy factories visited. The air in the rooms had a feeling of purity and sweetness, and one had very pronounced evidence of the dread managers had of germ life. Machinery, appliances, and the floors of buildings seemed to be bathed in strong lime water, while the inside and outside walls were kept very much under the influence of the lime. If the experience of the Danes goes to prove that taints have quickly disappeared in their cold climate since the use of lime became general, there are stronger reasons why the germicide should be more extensively used in warmer climates.

Lime Wash.—The application of lime wash to buildings should be freely carried out by dairy farmers and factory managers. Walls provide a harbour for filth which is a source of danger to the raw and manufactured produce. Illustrations of cultures of microbes and moulds from the atmosphere of uncleanly rooms are given in this work. These ruinous germs can be transmitted to dairy produce from the air by particles of dirt, and to overcome the evil, dairymen and factory hands should attack the proper source. The old axiom, " Prevention is better than cure," finds expression here. Corresponding to the dirt in the air, the rat carries the organisms of plague from place to place, but unless there is a congenial home for the rodent the distribution of the organisms will be restricted. The energies of sanitary officers are centred in purifying the source of danger by destroying the breeding grounds of rats. The dairyman should do likewise by disinfecting the walls of his buildings.

The action of lime wash on walls is to kill bacterial life, and to protect material against their attacks. The modern sprayer is an effective way of reaching the crevices and apertures of buildings, and its use is invaluable.

Recipes for Lime Wash—No. 1.—20 lb. lime (unslaked), 3 lb. common salt, ¼ lb. alum. Slake the lime with boiling water until the consistency of the wash is similar to rich milk. To increase its antiseptic properties, add ½ pint of crude carbolic to each bucketful of wash.

No. 2.—To half a bucket of lime add two handfuls of common salt and two handfuls of tallow, or, better still, soft soap, at the rate of 2 lb. to 30 gals. of wash. Slake slowly, stirring all the time.

This quantity will make two bucketfuls of wash, which possesses the properties of being very adhesive and unaffected by rain.

No. 3. Slake lime with water, and add sufficient skim milk to bring it to the thickness of rich milk. To each gallon add 1 oz. of salt and 2 oz. of brown sugar dissolved in water.

The germicidal value of Nos. 2 and 3 can be increased by the addition of ¼ lb. of chloride of lime to every 30 gals. of wash.

Before applying the wash to wooden, metal, or stone structures, precautions should be adopted to clean the surface of foreign matter, thereby increasing the benefits of the solution.

If any trouble is experienced through the lime wash scaling, the writer would suggest that less of the ingredients likely to give trouble—namely, alum, tallow, sugar—be added, and that the wash be applied in two thin coatings.

Precautions Necessary.—Where carbolic acid, salicylic, or formalin are used in the dairy the utmost care is necessary in their application. Readers should bear in mind that the more fatal a chemical body to germ life, the more dangerous it is to the human being. We sometimes hear of dangerous chemicals being employed to disinfect the teats of cows, hands of the milker, and dairy appliances. This should be discouraged. The writer has been an eye-witness of severe illnesses amongst young people through the indiscriminate use of disinfectants in the dairy. There is no objection to the use of permanganate of potash in the washing of cows' teats ; in fact it is to be recommended. Water that is faintly coloured with the permanganate crystals will be an admirable cleansing mixture, and it has the additional advantage of being sanitary and cheap.

CHAPTER II

THE CREAM SUPPLY

HAVING embodied in Chapter I. much that is necessary to ensure pure and healthy milk, we shall now deal with the cream supply, taking first the danger of inferior cans.

Inferior Cans for Milk and Cream

Defects in dairy produce, originating through inferior cans used for milk and cream, is a subject of considerable importance to the dairying industry. Cans made of inferior metal, with badly soldered seams, and constructed in opposition to effective cleansing, afford a hatching-ground for destructive microbes. And as the defective vessels continue in use crude repairs increase the danger. From the crevices or hiding places bad flavours emanate, which speedily develop in the raw produce under favourable conditions of temperature. Where is the remedy to be found against this class of contamination? The use of cans of hygienic construction, and a policy of thorough cleanliness, is the correct answer. The modern can is constructed of block steel, is seamless, easily cleaned, and possesses great strength and durability. In the cleansing of cans some farms, dairies, and factories exercise every precaution, while others are not properly equipped to sterilise the vessels in a satisfactory way, and are otherwise careless. It is to be regretted that more attention is not given to this question. Upon no account should cans be permitted to leave the milk depot or factory until the laws of cleanliness have been rigidly enforced, and at the farm washing should be repeated to eliminate all traces of taint.

Power to condemn cans which are a danger to the milk and cream supply should be vested in every dairy Act of Parliament, and vessels of suitable design and material substituted. By giving effect to this proposal there is no need to interfere with private enterprise and the liberties of trade. It is done in one country known to the writer with splendid results.

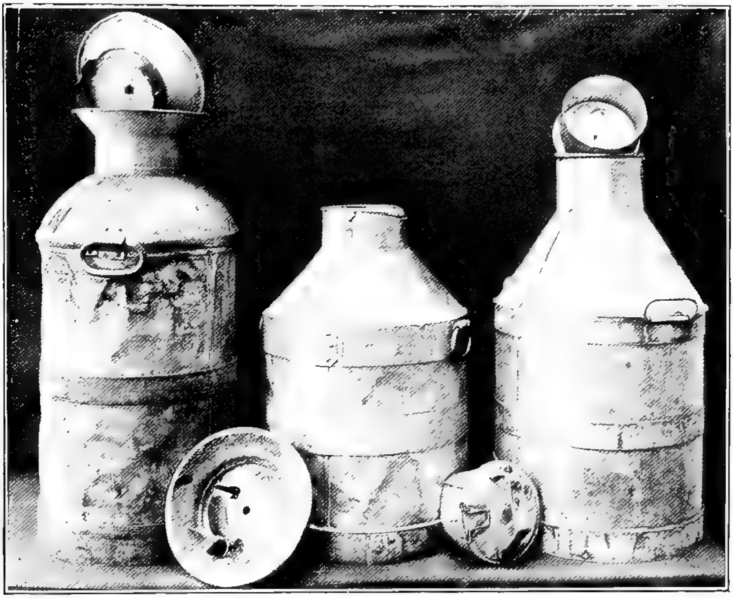


FIG. 6.—Inferior Cans for Milk and Cream (Thomson).

These vessels, as explained, are highly injurious to milk and cream. They are manufactured locally, and, all things considered, the cans are very expensive.

It is perhaps correct to say that many dairy appliances are put on the market which are not only very poor value for the money, but are a source of injury to all classes of perishable dairy produce, and it is difficult to understand why many very necessary appliances have to be imported into Britain and dairying countries of the Empire.

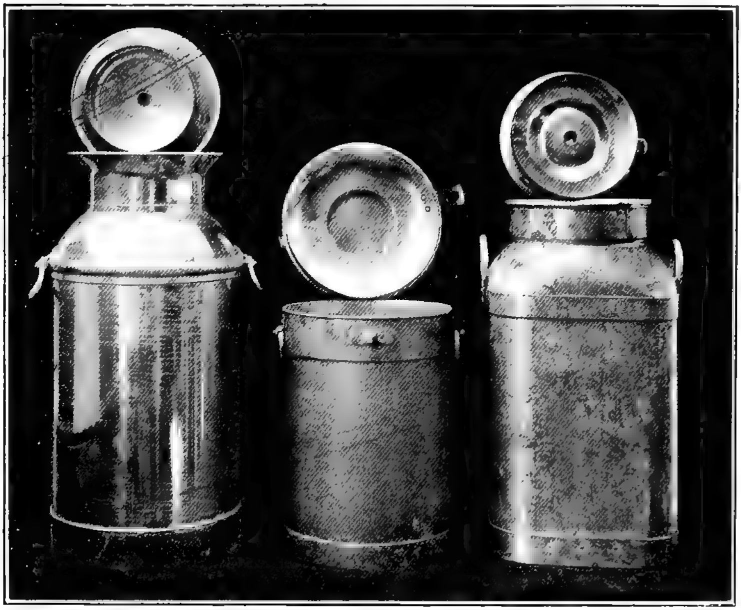


FIG. 7.—Block Steel Seamless Cans (Thomson).

In Britain all cans of superior design and construction are imported principally from Denmark. The additional cost on this account would appear to restrict their general use.

The following is a list of questions on the subject of milk and cream cans which the writer submitted to factories in an Australian State. The replies give the average opinions expressed by managers, and these should be carefully considered by persons associated with the industry in Britain and the Colonies.

Questions. —1. Can you give an estimate of the number of inferior milk and cream cans used by your suppliers?

2. In your opinion, what are the chief defects in the cans in use?

3. What proof have you that inferior cans are injurious to the quality of butter and cheese?

4. What class of can do you recommend?

5. Are the empty cans washed at your factory or creamery, and if so, what process is adopted?

6. As a cheese-maker, what are your objections to suppliers taking away whey in the milk cans? How can this be remedied?

Answers to Question 1.—One of the largest factories in the State writes as follows: "We would condemn 50 per cent. of our cans as unfit to carry cream." The majority of managers quote percentages, and express a general disapproval of the cans in use.

Question 2 brings forth the following comments: Rust and bad ventilation, loose bands, dirt accumulation in crevices, use of rag for collars, soap and white lead, narrow necks, too many seams, flat bottoms, inferior tin, dented cans, thin tin. Further extracts from managers' criticisms:—

"The general make of cans are of ordinary tin, with galvanised hoops, and some have an entire covering of galvanised iron on the outside. The latter are most troublesome, as the two materials get separated, allowing washings to get between the metals, which decompose."

"Factory cans are of the oldest make, consisting of very light tin covered with plain galvanised iron, soldered at the shoulder and at the bottom hoop. The solder breaks away, and leaves an opening where cream and other matter is allowed to clog between the galvanised iron and the tin. It is impossible to clean this out, and the layer of matter remains to rot."

"It is almost impossible to clean the inside of a rusty can thoroughly. If a small speck of dirt is left, it may cause the cream to ferment. Numbers of cream cans have practically no ventilation. This is encouraged by some factories to save cleaning the ventilation pipes. Good cream is spoilt through this defect, there being no means for the escape of gas generated in transit."

Question 3.—"Inferior cans have a very injurious effect on milk and cream, owing to the fact that they cannot be properly cleaned, and the bad effects are transferred to the cheese and cream vats. Rust creates a disagreeable smell, and gives a disagreeable flavour to the cream."

"Rusty cans cause milk to sour quickly."

"Inferior cans in the hands of careless people are not thoroughly cleaned."

"The effect of a dirty can is obvious."

"I am convinced that cream received in a fermented and rotten condition has been caused by the vessels."

"Rusty cans will destroy both the colour and flavour of cream."

Question 4.—"We approve of cans with mouths sufficiently wide to allow of thorough washing and good ventilation."

Question 5.—"All cans are washed with tepid water and soda, then steamed for half a minute; the ventilation holes in the lids are thoroughly cleansed and steamed."

"Cans are washed with cold water, afterwards in hot water with soap and soda, and finally steamed for two minutes and exposed to the air."

In the cleansing of cans, writes a manager, the following weakness is shown:—

"At the depot cans are rinsed before being returned to the suppliers, but in the case of the travelling waggons, suppliers are responsible for the cleaning.

"Cans are not washed at factory. Strongly recommended that all cans be washed and steamed before being returned to suppliers.

"Cans are washed before being returned. This washing is only to clean the cans, and is of little or no value, as cans are soon lidded and returned to the suppliers. They should be thoroughly cleansed before being used again."

The foregoing answer came from one of the largest factories in the State. One factory recommends the use of lime water to sweeten the metal. At another factory a trough is provided, where suppliers wash and steam their own cans. If a can is found to be in a dirty condition, the manager causes the can to be cleansed to his satisfaction. Manager concludes answer by stating that more cream is ruined by dirty cans than by any other cause. Another says :—

"Cans are washed and steamed at the factory, and should be again washed at home before being used, on account of the bad smell caused by the exposure of the cans to atmospheric heat."

Question 6.—"Managers object to carrying whey in cans, owing to its corrosive nature."

"Suppliers are not allowed to take away buttermilk in their cream cans. This practice was permitted some years ago, but was discontinued, as it was found very injurious to the cream, some suppliers not taking the trouble to rinse the cans before they were used again. I think this is a practice which drastic measures should be taken to stop."

"Carrying whey in cans: This is a very objectionable practice, and would recommend that it be put a stop to at once."

It is not intended in this work to deal with the separation of milk ; that important branch is fully reviewed in the author's book on "Milk and Cream Testing, and Grading Dairy Produce." Suffice it to say, however, that the manufacture of separators has received a great impetus of recent years, and there are now at least thirty different makes on the market. There are other subjects of concern to successful butter-making which should commend the serious study of the practical dairy worker and student. The first of these we shall now take.

Fat Standard of Separator Cream

The writer will endeavour to explain in practical language how marked differences in the component parts of cream influence the flavour and keeping properties of butter. Cream of a thin consistency is short-lived in hot weather, that is to say, the development of acid is very rapid in the presence of large quantities of bacterial food.

The lactic organism, which is the valued ferment, produces in thin cream a high percentage of acid. The ripening stage, at which the much desired sweet acid flavour is produced, is of short duration, its valuable properties giving place in a few hours to a strong, harsh acid. As soon as the lactic organism completes its work in cream of thin consistency, very objectionable bacteria attack the abundant supply of casein. Similar changes take place in milky butter, and the name "rancid" is given to denote the dreaded flavour produced. In cream containing more fat, the smaller proportion of sugar and casein provides a less favourable field for the multiplication of bacteria, which enhances the keeping properties of the product. It might at this interesting stage be queried, What is the effect on the quality of butter when quantities of thin and thick cream are mixed and churned? Supplies having different percentages of fat, different quantities of acid, different degrees of density, and having undergone dissimilar chemical and bacteriological changes, would be highly injurious to the butter. This danger has to be specially guarded against in the classification of cream. It will be gathered from the above explanation that the practice of supplying cream to factories, which varies greatly in the fat percentage, is hurtful to the best interests of the industry, and efforts should be made to rectify the error. With thin cream travelling a long distance in the heat of summer, churning of the fat and coagulation of the non-fatty solids are a natural consequence, and when this quality is blended with a thick product, mottle, streakiness, and defects in the colour of the butter are caused. In addition to this, water percentage and weight are influenced to a more or less extent.

From what has already been written the reader will recognise that a fat standard for cream should be the object of all factories and suppliers, and it is suggested that 35 per cent. be considered to meet the requirements of Australia and South Africa. In European countries a summer and winter standard would be necessary. The writer's extensive experience of a fat standard which he introduced in Queensland, with great benefit to the industry, enables him to thoroughly prove his contention.

Even Consistency of Fat and Non-Fatty Solids in Cream.—Where there is no fat standard there will be a very marked variation in the density of the cream supply.

To prove this, let the reader take two thoroughly clean glasses and put into each a sample of cream from the same separation, one containing about 20 per cent. of fat, and the other about 35 per cent. By exposing the glasses to similar atmospheric conditions the rich cream will be found to retain its sweetness longer than the thin cream.

Uniformity in Ripeness.—Every dairy farmer knows that the best butter is made from well-ripened cream of even consistency, and in which the fat percentage is uniform. As soon as thin and thick supplies are blended there will be a badly diffused acidity, because the sugar of the cream in some instances will not have been appreciably affected, whilst in other cases the process of fermentation will have exceeded the requirements of a fine aroma, and bitter flavours will develop. How will this affect the butter? Sugary matter will be left in the manufactured article to ferment, and the bacteria of butyric acid will also be retained to attack the casein, and especially where supplies are mixed the difficulty to get rid of the milky water is increased, owing to the uneven distribution of the component parts of the blended creams. It is a fallacy to believe that cream of different density can be mixed sufficiently to prevent hurtful changes in butter. It is in these matters that science is helpful, but the practical man knows that butter made from sweet cream will quickly lose its flavour, while the well-ripened and unmixed product can readily be converted into a choice article. Blend the ripe and sweet supplies and then churn, and the result will be disappointing. It cannot be too pointedly said that uniformity in the flavour of butter is the key to success. This is obtained from uniformity of ripeness of cream, the necessity of which has been explained.

Uniformity in Churning.—In cream which contains all that is required for the manufacture of a high-grade article, the churning will be uniform, that is to say, the cream will give up its particles of butter fat at the same time; but when the supplies are opposed in fat, casein, sugar, albumen, acid, etc., and mixed carelessly, the cream will break unevenly, causing more fat to escape in the buttermilk. In churning cream of uniform density and ripeness the time occupied will be more regular, and the butter produced will retain its choice flavour for a longer period.

When cream fluctuates in the percentage composition in the manner described, and is churned without attention to ripening, the analyses of different portions of the butter would probably show a variation.

Experience has demonstrated beyond dispute that a fat standard renders butter better able to withstand the hurtful influence of atmospheric heat before and after refrigeration. This alone is an important element in support of the fixing of a standard.

Evils of Thick Cream.—In the foregoing pages a thin cream supply for butter-making has been freely criticised, but the writer's object for this must be intelligently followed. When butter-making is conducted on the farm the same density of cream will be separated from day to day. Very successful results are obtained from a thin skimming, and the same will apply to thick cream provided ripening is carried out as it should be. It is found advantageous to churn a thicker cream in the summer months, and a thinner product in the winter season for obvious reasons. What the writer expressly wishes to explain here is the mistake of supplying cream to factories in so thick a condition that it practically drops from the can in a lump. This class of cream will not ripen, and in the winter months the trouble is greater. Inspections made by the writer at some English factories has shown how very faulty the supply arrives. Some producers send thin, watery cream, others fairly thick, and quite a number of the condition above mentioned. There is no such thing as an even consistency or density. It might be asked, What can the result be when large quantities of thick cream reach the factory partially churned and are delivered into the ripening vat with supplies that have no relationship to each other? The manufacture of choice butter in the face of these conditions is an impossibility. Unfortunately, English factory dairying has begun without the guidance that the country should have been in a position to give, and the result is illustrated in the poor class of butter that is frequently produced. The skimming of thick cream by careful farmers—a product that contains between 45-60 per cent. of butter fat, may, however, be shown to have some advantages, namely, a little more separator milk is obtained for home use, fewer cans are required, and a smaller size meets the purpose, also the richer the cream, fewer deliveries are possible. The latter is an advantage in disguise, and may figure on the wrong side of the company's balance-sheet.

Age of Cream and the Butter Ratio.—The ripeness or degree of acid is a responsible element in the butter ratio of cream. If the percentage or quantity of acid is high, churning will be hastened, and the dangers of the fat escaping in the buttermilk increased. Proof of this will be found in the following percentages, which illustrate thirteen successive tests made by the writer:—

	Percentage of Acid in Cream at Churning.	Percentage of Fat in Buttermilk.		Percentage of Acid in Cream at Churning.	Percentage of Fat in Buttermilk.
High Acidity.	0.89	0.4	Good Average.	0.56	0.2
	0.80	0.4		0.57	0.2
	0.88	0.6		0.57	0.2
	0.90	0.6		0.55	0.2
	0.84	0.5		0.55	0.2
	0.84	0.6		0.55	0.3
	0.63	0.3			

From these figures it will be gathered that the losses in fat increased when the acid exceeded 0.57 per cent., and this would be more pronounced with a high temperature at churning. In other experiments it was found that cream with 0.85 per cent. and 0.90 per cent. of acid did not lose much of its fat when the churning temperature was kept below the average. The above illustration, however, is not associated with suppliers' cream, but with cream separated in the factory, otherwise the fat losses would have been heavier, caused by want of uniformity in ripening and the greater age of the product. It must be accepted by farmers that age of cream seriously affects the butter returns, and what must the waste be in some cases where cans of cream are sent many miles by road and rail, and exposed to the hot sun for hours? The changes that are produced work disaster in the body of the product to an extent that refrigeration fails to save the valued fat from passing away in the buttermilk.

It is reasonable to expect that before acid cream arrives at the depot or factory, a proportion of its fat will be churned into minute grains of butter. It must, therefore, be admitted that throughout the hot summer weather the fat readings cannot be the same day after day. Under these conditions fat testers are compelled to deal at one time with a supply of sweet and fresh cream ; the next supply is curdled ; chemical and bacteriological influences have been at work, and unsatisfactory fat percentages follow. Paying by results will never be free from adverse criticism and objection until cream is sent to factories more frequently and in a fresh condition. (See Treatise on " Milk and Cream Testing.")

Mixed Cream and Butter-Making

Let us add to this chapter an explanation of the above subject. Sweet and acid supplies that have been mixed together shortly before churning will lower the butter ratio, as the ripe cream will yield its globules of fat to be changed into butter sooner than the sweet cream. Let us take one example, where the period of ripening occupied fourteen hours, and the time of churning fifty-three minutes. The few hours given to ripening and a cool cellar selected for the cream (as it was in this case) would naturally lead one to expect that its condition at the time of churning would show a low acidity. This was the case as determined by accurate tests. When sweet cream is churned at a high speed and temperature, a considerable loss of butter fat follows, and in the example given we may attribute the deficit to this cause. The loss of fat in the buttermilk reached the unusual percentage of 1.4. Now, assuming that this cream had been mixed with an acid quantity six or eight hours before churning, what would have been the gain ? Churning would have taken less than fifty-three minutes, and the cream would have given up its fat more profitably.

Farmers Checking Factory Returns. A comparison in the weight of butter made on the farm with that of the factory, from a well-mixed supply of cream, is certainly useful to show the value of improved methods in the manufacture of the product. The want of suitable appliances on the farm, and the action of high temperatures, may cause as much as 20 per cent. of water to be left in the butter, against 12 per cent. in the factory article.

In order to obtain equal results from two given quantities of cream, the following conditions must practically correspond at the time of churning:—

1. Consistency of cream.
2. Percentage of fat.
3. Ripeness or degree of acidity.
4. Temperature of churning.
5. Kind of churn.
6. Quantity churned.
7. Speed of churn.
8. Method of washing butter.
9. Temperature of washing water.
10. Working butter.
11. Salting butter.

1. If the consistency differs, there will be a variation in the fat percentage of the buttermilk, as thick cream under ordinary circumstances churns quickly, and the difference in the time will influence the yield of butter.

2. When supplies of cream of equal weight or capacity vary in proportion of fat, and both contain the same percentage of acid, and are treated in exactly the same manner, there will certainly be more butter got from one lot than the other.

3, 4. Ripeness and temperature have already been explained.

5, 6, 7. Difference in make of churn and the handling of same will alter the butter ratio of cream. One churn might be too large or too small, and the concussion which accounts for the breaking of the cream into butter grains will accordingly vary; also the quantity churned and the regularity in speed of churn will influence the yield of butter, and the fat percentage of the buttermilk.

8, 9. Overwashed or underwashed butter will raise or lower the weight of the finished product. Insufficient washing will increase the weight, while that which is properly washed, thoroughly drained in the churn and the water carefully worked out will give an opposite result.

10, 11. When butter grains are heavily brined in the churn, or a large percentage of dry salt added on the worker, an increased quantity of water is left in the butter, thereby adding to its weight; also the following conditions influence the yield of the product, viz.: drainage of butter in churn, temperature of washing water, temperature of cream, and season of year.

The following will complete the rules:—

12. Cream must be equally ripened.
13. Cream must not be too thick or too thin.
14. Cream must not be heated or damaged in transit.
15. Cream must not be sent in unfilled cans.
16. Cream must not be injured with preservatives.
17. Cream must be churned in a suitable churn.
18. Cream must be churned at a suitable temperature.
19. Butter must be carefully washed in the churn, and worked with caution.

What do we learn from these rules? That the farmers are suffering through butter fat deficits in the churning of mixed cream; contention between farmer and manufacturer is ever occurring, and we hear of farmers keeping back half of a day's supply and churning it at home, with the result that the yield of butter seldom compares with the factory. Before similar results can be obtained in the treatment of a most delicate substance like cream, let it again be repeated that conditions must be the same from first to last. Exposure to heat and jolting on a rough road for a few miles will reduce the butter ratio of a can of acid cream by pounds. In further consideration of the last table of directions, the writer might emphasise and explain the dangers which accompany the transit of consignments of cream in partly filled cans. When this is done, and the product has to suffer shaking during long journeys, partial churning of the fat follows. This condition is more marked in the summer months, while in the cold weather difficulty is sometimes found in getting the fat globules to unite, the cream showing a sleepy condition. Such may also take place in hot weather, particularly if preservatives are used, as the natural ripeness in cream is arrested, and the escape of fat in such cases will be unusually high, while, in addition, the butter suffers in flavour.

From what has been written in the foregoing pages, it is to be hoped that suppliers and all those having a special interest in dairying will study each phase carefully, and do all in their power to minimise the causes that are retarding the progress of the industry. Factories should receive the support of their districts, as the less handling that cream receives the better for its butter ratio, and the quality of the product manufactured. It cannot be too widely known that the use of the most modern improvements in the equipment of dairy factories, not the least important of which is refrigerating machinery and cool storage, enhances the money value of butter, and saves serious losses in the aggregate returns from the dairy herd. This subject, however, will again be referred to in another chapter.

"Pooling" Cream

One of the most ruinous practices connected with the dairying industry of any country is the pooling or indiscriminate blending of supplies of collected cream. Through the agencies of factories, keen competition for the patronage of cream supplies results, and to cater for the raw product carts employed by the factories visit the farms and collect the cream. Pooling, however, is more particularly followed in the Colonies, and it will be to the benefit of new dairying countries to be fully warned of the abuses that have been introduced by the practice. It has been shown that a very important factor of cream is its age, and this is regulated by the frequency of the draymen's visits, but the most disastrous element emanating from the system is the filling of cans with different supplies picked up *en route*, and in which the fat percentage, age, flavour, body, and colour are at variance. Injury to the industry is made all the more damaging through the absence of opportunities for the butter-maker to train himself in the grading of cream, and improve his knowledge in this the most important branch of factory management. There is only one remedy for the pooling of cream, and that is the compulsory carriage of all supplies in the original can.

Other Dangers.—There are other serious dangers menacing the success of butter production, and which are the direct outcome of pooling. The writer refers to sampling of supplies by untrained persons. Consider for a moment this vital duty being entrusted to the inexperienced. In such a case the farmer is at the entire mercy of irresponsible persons, and he is paid according to the fat content of the samples collected by them. In their own interests it is to be hoped dairymen will emphatically denounce the waggon or the roadside as a proper place for taking the sample of cream, and they should insist upon this very important duty being done in the depot or at the factory, and by one who is skilled in testing, and thoroughly acquainted with the dangers which surround the practice. No doubt the difficulties occasioned by the cartage of unpooled cream will be raised as an objection to the practice the writer has criticised, but the use of double-decked waggons, in which accommodation is provided for two tiers of cans, would obviate any serious inconvenience which might arise. In the case of small supplies of cream, two or three mixing cans may be used for first or second grades.

In concluding this subject, the writer may be permitted to tabulate the serious objections to pooling, so as to convince the doubtful of the urgency for reforms :—

1. Pooling encourages the storage of cream on the farm, where it has to wait removal by the carter.

2. Temperature of supplies varies, and this is hurtful to the quality, and endangers sampling.

3. Dishonesty is encouraged in manipulating the sample, and the possibilities of errors in fat results are considerable.

4. Fresh, ripe, stale, weedy, thick, thin, rich and poor cream are blended together.

5. Sample bottles for cream which are used extensively are frequently dirty, and augmented by age, the cream readily ferments and becomes spongy and gassy, causing a low and variable reading of fat. Delay in delivery of samples exposes the cream to changes which interfere with the accuracy of testing.

6. Fat tests of pooled cream and churn results often disagree, and this is more marked when a fat standard is not insisted on.

7. In transferring pooled cream into carters' cans at the roadsides, small quantities are left in the "empty" vessels. In hot weather this cream deteriorates rapidly, and when the cans are returned to the supplier, difficulty is experienced in cleansing them sufficiently to prevent fresh supplies from suffering in flavour. The use of the approved squeegee, as recommended by the writer, would facilitate the more thorough washing of the cans, but the danger to the cream would not be dispelled.

8. Collection cans are usually inferior, as well as being badly washed.

From what has been written, there is strong evidence to show that weighing, sampling, testing, and grading of cream should be done by certificated men in all dairying countries.

Storage of Cream.—The storage of cream on the farm is in a number of instances made compulsory, owing to a frequent delivery being prevented by long distances from railway stations, depots, and factories. In such cases special consideration should be given to the conditions under which the product is kept, with a view to retard fermentation in the cream and injury to the quality of the butter. As already pointed out, the dairy, or cream store-room, should be thoroughly protected against the agency of heat, and at the same time light and ventilation must not be sacrificed to attain this object. If the dairy is provided with an underground cellar, special precautions are necessary, and in the cold months of the year it is advisable to keep the cream in a warmer and purer atmosphere, to prevent the development of bitter and other injurious flavours. Low temperatures are no doubt indispensable in the hot months of the year to

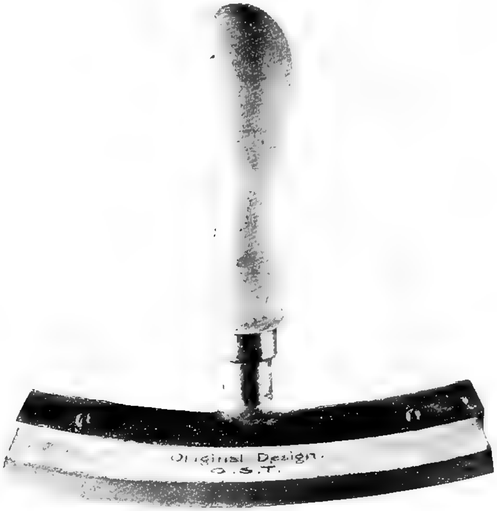


FIG. 8.—Squeegee for Cleansing Cream Cans (Thomson).

check ripening, but in the winter weather the fermentation or the growth of the lactic organisms has to be encouraged. Special precautions are also necessary to safeguard against damage, through the storage of cans in the cool chamber, which is a customary thing in small factories. To obtain regularity in acidity or ripening, the use of cream vats, situated in an atmosphere where an outlet and inlet for air are provided, gives the best result in quality and yield of butter. There is also to be considered the suitability of the pumps and other appliances used in the treatment of the cream, for it is known to the writer that much damage has been done to butter through the defective construction of pumps, and the imperfect cleansing of same.

Churning Point of Cream

There is a great deal associated with this simple change of cream into butter which should be seriously considered by students and butter-makers. The breaking point of cream is the pulse of the churn so to speak, and no responsible person can afford to ignore it. When churning is slow, when cream goes to sleep, or when the breaking stage is quick and uneven, the cause should commend the attention of the butter-maker. In treating the subject let us first consider the influence of fats on the churnability of cream, and, by the way, the name churnability was first introduced by Mr Primrose M'Connell, the well-known author of " The Agricultural Note-Book." Fats play a very important rôle, and the writer's connection with dairying in Great Britain, Australia, and other countries gave him opportunities to study phases of the question that are not usually found in any one country. It is only by experience of different breeds of cattle, different foods, different climates, and different conditions of dairying that one can fully appreciate the factors that affect the churnability of cream. With these observations, followed up by actual practice in the classing and grading of produce on educational lines, the most valuable of results are obtained.

One does not usually apply the word texture to a fluid body like milk, but it will be observed that under certain conditions it is not out of place to use the term. Milk varies considerably in fatty and other solids, and possesses properties that warrant an expressive word, other than rich or poor.

Breed and Individuality of Cows.—Some breeds produce milk containing a high percentage of fat, others yield an inferior quality, while the milking propensities of animals of all breeds are found in some cases to be exceptionally well developed, or quite the reverse. In the Jersey, Guernsey, and Alderney breeds the fat yield is high, the globules are large, while in other breeds, particularly the Ayrshire, the globules are of a smaller and more regular size. The texture of the milk of the Channel Island cows is more oily and more subject to damage by the agencies of heat, acid, and movement, while the milk of the Ayrshire breed will retain its good texture for a longer period under the same adverse conditions. The writer has observed, in districts where Jersey cattle predominated, that the churning of cream in transit to butter factories was of far greater occurrence, compared with supplies received from similar parts of the country, where the Channel Island cows were outnumbered by other dairy herds. And this experience was supported by the quicker churning of the cream and a higher percentage of fat in the buttermilk.

Further proof of this may be found in cheese factories where the escape of fat in different stages of manufacture is more liable to occur with rich milk.

The writer has confirmed what has been written in the foregoing paragraphs by the sampling of manufactured produce at butter and cheese factories in countries where he was engaged in an official capacity. By the flavour and texture of butter, Government graders are able to tell where different makes come from. In Australia the writer has frequently had convincing illustrations of this, as well as having himself located the manufacturing centres by the examination in Australia of export produce, and also upon delivery of the butter in the London market.

The Fat Globules. -The size and regularity of the fat globules in milk and cream claim the close attention of the butter-maker, because the churnability is influenced by these conditions. When the milk or cream of mixed herds is used for butter or cheese making, the losses of fat under average conditions of manufacture will be higher, compared with supplies from separate districts, where one breed of cows is principally kept. That is to say, milk or cream containing globules of fat of one size will yield a higher proportion of butter or cheese than is obtained from mixed supplies. In the ripening of cream that is produced in a district where one breed of cows is favoured, there will be a more perfect exposure of individual globules of fat to the releasing influence of the lactic acid in the cream, causing a quick and easy escape of fat at the breaking stage in churning. In mixed supplies from different breeds this will not occur to the same extent, consequently the loss of fat in the buttermilk will be increased.

Separator and the Fat Globules.—In separating milk, damage to the globules of fat is likely to occur principally at periods of the year when the texture of the milk is weak, and the injury will be increased with rich milks. Rupture of the fat cells will take place more readily for a couple of months or so after cows come into milk, and when the herbage is rank or immature the danger will be greater.

Influence of Food on the Texture of Cream and Butter. —That food plays an important part in milk is referred to in this book, and what the writer wishes now to deal with is the influence of food on the texture of cream and butter. It is well known in Britain that certain food rations will give a harder butter, while others produce a softer texture; also one finds in countries where the dairying districts represent both a tropical and a cool climate that cream has to be churned at temperatures which experience of the local conditions has shown to be profitable. While the atmospheric conditions have to be taken into consideration, the kind and quality of the food of cows plays a very important part in deciding the texture of cream and butter. The writer used to frequently visit a number of butter factories which were situated on both sides of a range of hills, and only a few miles distant from each other. The difference in the texture of the cream supply of these factories was strikingly illustrated by the churning temperature in one case being high, and in the other low. That the food was responsible for the condition of the cream was proved by the fact that the breed of cows was the same on both sides of the range, and the climate showed no difference. The soil was light and the herbage short and sweet on one side, but on the other side there was a richer soil and a more vigorous herbage, which dried off at a period of the year when the cream should have been at its best. In a series of feeding experiments which the writer conducted for the South Australian Government in 1901, to determine the value of cocoanut cake as a food for cows, the following extract is taken from the report.

Points of Interest.—Every possible care was taken to ripen the cream thoroughly, and before the experiments were commenced, quantities were retained from the cows for comparative tests, with the following result:—

	Cows fed on Rations without Cocoanut Cake and Bran.	Cows fed on Rations including Cocoanut Cake and Bran.
Consistency of cream.	Thin after ripening.	Thicker after ripening.
Condition of butter grains.	Firm.	Distinctly firmer.
Flavour of butter.	Sweet and clean.	Sweet, with a cocoa-nut flavour.

Analyses of Butter from Cows Fed on Cocoanut Cake and Bran, and from Cows not Fed on Cake and Bran

Percentage of Fat.		Percentage of Water.	Melting Point.	With and Without Cake and Bran.
Test I.—				
Ration 1 -	86.12	10.54	89°	with.
	85.69	10.37	88°	without.
Test II.—				
Ration 1 -	90.59	6.68	89°	with.
	89.68	7 07	79°	without.
Ration 2 -	89.27	7.13	90°	with.
	87.68	7.58	89°	without.
Ration 3 -	89.11	7.26	84.5°	with.
	87.68	8.36	91°	without.
Ration 4 -	88.07	9.40	91°	with.
	88.07	9.05	90°	without.

It will be observed from the table that the butter from cows that received the cake and bran, with one exception, shows a higher melting point, and a slightly lower percentage of water. This result will further serve to illustrate that the milk contained a higher percentage of hard fats from the cake and bran ration.

Collecting Cream from the Separator

We have dealt very fully with the cream supply after it leaves the farm ; let us now give a little attention to the gathering of the cream from the separator. We might ask ourselves the question —Is there any importance attached to this feature of butter production, and has it an influence on the quality of the butter? Let it be accepted that the way cream is frequently gathered and kept at the farm affects to a considerable extent the success of the factory, and if butter is made by the dairyman himself, he will have sufficient proof at hand to cause him to fully appreciate the value of a correct system.

A Wrong Way.—Separating the cream into the factory can without any further attention is a deadly blow against the virtues of the product, and if this is repeated morning and night there will be layers of cream in the can that will be encrusted, and chemically and bacteriologically opposed to each other on the arrival of the supply at the factory.

Correct System.—Provided with a clean, airy room, and the separator as it should be carefully balanced and thoroughly clean —we set to work with two elements in our favour. The next step of importance is the cream can, but one vessel is not sufficient It is well to have three at our disposal. One is the mixing or stock can, the second is used in conjunction with the separator, and the third for cooling purposes if required. We are now ready to start. The milk is put through the separator according to the rules of all well-conducted dairies, and the cream passes into the delivery vessel, preferably over a simple cooler, which has the advantage of aiding in the escape of animal flavours from the cream. In the absence of a cooler, we fall back on the third vessel. By pouring the hot cream from one vessel to the other a few times a reduction in temperature is obtained, and in the third vessel the cream is allowed to remain until it is in a fit condition to be transferred to the mixing can. Between the morning and evening milking the cream should be periodically stirred, and immediately before the next separation begins it is added to the mixing can. As this is the first gathering of cream it is not necessary to stir it more than a few times, but after each fresh addition of cream, morning and evening, a good stirring to incorporate the old with the new cream, so to speak, is necessary. The chief advantages accruing from this system are as follows:—

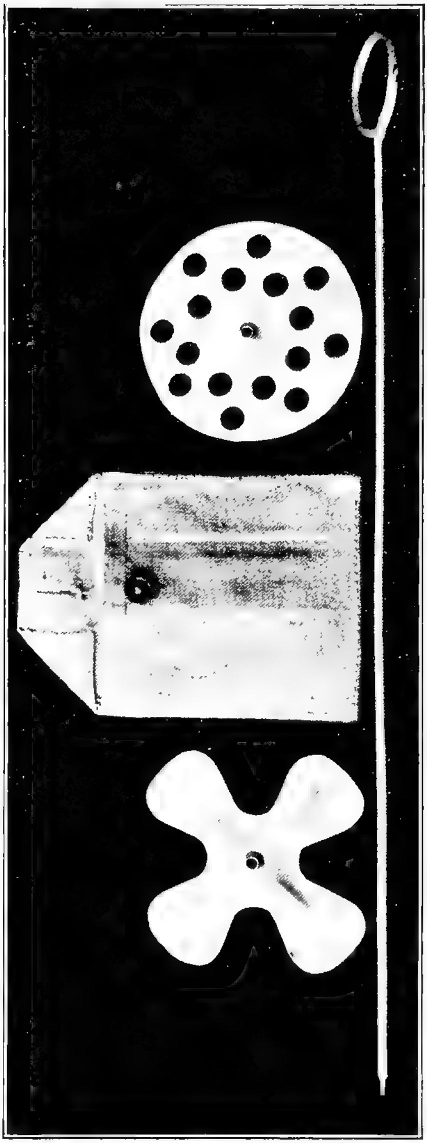


Fig. 9.—Thomson's Portable Cream Mixer and Plunger for the Use of Dairy Inspectors and Farmers.

(*a*) The fresh warm cream from the separator undergoes a process of cooling and airing.

(*b*) It is added to the mixing can in a condition that incorporates well with the previous gathering.

(*c*) An even density or consistency is obtained in the cream when it goes to the factory.

(*d*) Where acidity has developed less injury is caused.

(*e*) Fat testing of the cream is more likely to be accurate.

Bad Flavours in Butter Produced by the Wrong System.—It is a simple matter to determine, by the flavour of butter, if the collecting of cream on the farm has been done on the one vessel system. If it has, the flavour of the butter will, in all probability, be cowy, resembling the taint of a cow-shed in the early morning. This is due to the animal odours of the cream becoming locked up in the product, and with other defects the taint is reproduced in the butter. It is recommended to deliver cream to the factories daily in the summer months, or where this cannot be done, every alternate day should be insisted upon. Beyond this period cream very quickly decreases in value, particularly in warm climates.

Pasteurising Cream

REFORMS THAT ARE URGENT

As already stated, the pasteurisation of cream for butter-making is universally followed in Denmark. In New Zealand it is now general, and in the western districts of Victoria, and in some parts of New South Wales, the system is proving very successful. To thoroughly succeed with pasteurisation, a pure milk and cream supply is necessary. With hand-separator cream it is not possible to obtain the same good results, as careful ripening is essential to the production of fine flavoured butter. One might inquire, Where and how does the lactic germ find an entrance into cream that is not ripened by the use of a starter? Aroma-producing bacteria always abound in the dairy, and if sweet and carefully selected cream is exposed to the free and uncontaminated air of the milk room the germs will grow and multiply, and good-flavoured butter will be manufactured. Again, if the same dairy is unattended to, an injurious invader will take possession, and butter of a poor keeping quality will result. If a preservative were added to the cream in a well-kept dairy, no longer would the butter have the same attractive flavour which it previously possessed—the desired ferment would find a poison in the preservative. It is well understood amongst butter-makers that when the lactic bacteria have an uninvaded field for their multiplication, their rapid growth crushes to death and cripples the less numerous germs. This feature is strikingly illustrated in the system of pasteurisation. Pasteurising or scalding cream clears the ground of intruders. The scientist discovers that a good field, free from troublesome weeds, gives a seed-bed favourable to a careful sowing, and there he scatters the seed as a pure culture of germs, to grow and multiply and produce in the cream their own distinct and attractive flavour, to be finally tasted in the butter.

When milk is received at butter factories every can should be examined, and what is not up to the standard should be rejected. In the opinion of the writer pasteurisation of milk only is sufficient in countries that are manufacturing butter purposely for local markets. It has not only the advantage of being inexpensive, but it improves the general quality of the butter, and it reduces the dangers of tubercular disease being spread amongst stock through the use of infected separated milk. But where butter is made for export, and in a sense is "aged" when it reaches the consumer, the Danish system of pasteurising has very apparent advantages. This book has put strong emphasis on the grading of cream by all factories. When it is bought on a basis of flavour and fat, the pocket of the careless is touched, and that will go far to reform vital departments of the industry. And here it might be asked, What is the use of a costly system of education when factories openly encourage carelessness by paying fictitious prices for inferior produce? Those responsible for the dairying industry of the various sections of the British Empire should strike a determined blow at the chief evils. Those who have followed the line of least resistance have a good deal to answer for.

The table on p. 68 gives the result of an experiment showing the keeping properties of sterilised (so called) and preserved milk, compared with pasteurised and raw milk, also milk contaminated with dirty water, compared with a similar sample containing a borax preservative.

Danish System of Pasteurising

The aim of the dairying industry of any country is to place on the market produce that will command the favour of the public, and yield an encouraging profit to the producer. To fulfil this high ideal the produce must possess a choice flavour, have uniformity, and good keeping properties. In this direction Denmark has been successful.

The writer has made a full study of Danish dairying, and will give an outline of the system of pasteurisation generally followed. At the farm the milk is placed in cans, which are lowered into wells of cold water, and kept there until removal to the factory. Delivery takes place once a day, from 7 to 10 A.M. The milk is carted by the farmer to a meeting-place on the public road, where it is picked up by the waggon. When the milk reaches the factory, it is weighed and run into a large tank. From the tank it is conveyed to a heater, and raised to a temperature varying from 40° C. to 45° C. (104° F. to 113° F.). The milk now passes into the separator, and the skim milk is carried

TABLE OF A TEST CONDUCTED BY THE WRITER TO SHOW THE KEEPING PROPERTIES OF STERILISED AND PRESERVED MILK, ETC.

Hour and Date of Testing.	Sterilised Milk Temperature 212° F. for Ten Minutes.		Pasteurised Milk—Temperature 185° F. for Ten Minutes.		Raw Milk.		Inoculated Milk. Without Preservative.		Inoculated Milk. With Preservative.	
	Per cent. Acid.	Condition.	Per cent. Acid.	Condition.	Per cent. Acid.	Condition.	Per cent. Acid.	Condition.	Per cent. Acid.	Condition.
4th June— 2.15 p.m.	0.20	Sweet	0.20	Sweet	0.20	Sweet	0.20	Sweet	Before adding preservative. 0.20	Sweet
7.30 p.m.	0.21	Sweet	0.22	Sweet	0.25	Sweet	0.27	Sweet	After adding preservative. { 0.35 0.41 }	Sweet
10.30 p.m.	0.21	Sweet	0.22	Sweet	0.32	Slightly acid	0.43	Acid	0.42	...
5th June— 9.30 a.m.	0.21	Sweet	0.22	Sweet	0.78	Sour	0.80	Sour	0.45	...
1.30 p.m.	0.21	Sweet	0.22	Sweet	0.88	Thick	0.84	Thick	8.47	Sweet
7.30 p.m.	0.22	Sweet	0.22	Sweet	Coagulated	...	Coagulated	...	0.57	Faintly acid
6th June— 9 a.m.	0.28	Sweet	0.34	Faintly acid	...	..	...	...	0.67	Acid
9 p.m.	0.73	Acid, but liquid	0.80	Acid, but liquid	...	...	...	...	0.90	Very acid, but liquid
7th June— 9 a.m.	0.91	Liquid	0.95	Thick	...	...	...	...	0.90	Very acid, but liquid

to the pasteuriser and heated to 85° C. (185° F.), and finally runs into the cans from where the whole milk came. The cream from the separator passes over another pasteuriser at a temperature of 86° C. (186° F.), after which it is immediately cooled to a temperature not higher than 8° C. (46° F.). From the cooler it goes to the cream barrels, which contain the necessary amount of starter. Repeated stirring is done to produce even ripening, and the temperature of the cream is not allowed to exceed that of the cool, airy room. With all conditions satisfactory, it is ready for churning in the morning.

The following reprint on pasteurising is supplied by the manager of an up-to-date Australian factory:

"The method usually adopted is to submit the cream as soon as possible after being separated to a temperature varying, according to the local conditions, from 170° F. to 180° F. The heating apparatus, termed pasteuriser, takes in the milk at the base and slowly elevates it in a thin layer over the inside surface, which is heated according to requirement by a steam jacket. The outlet pipe, which is situated at the top of the pasteuriser, carries the cream to the cooler, over which it flows, and is quickly reduced to a temperature at which the organisms will grow rapidly. No time should be lost in adding the pure culture, which should be in the proportion of from 5 to 10 per cent. of the volume of cream.

"Should any delay occur in adding the starter, it is quite possible that spores of unfavourable bacteria that might escape destruction by the process of pasteurisation will develop, and make their presence known in the butter by a foreign or 'off' flavour. To carry out this method of ripening cream satisfactorily, the cream tanks should be jacketed, so that when it is found by the alkaline test that the cream has reached the degree of acidity which has been proved by practical observation to give the best results (this varies, of course, in different localities), it can be quickly cooled, either by a direct expansion coil, or by a circulation of artificially cooled water, to a temperature at which fermentation practically stops—which would also be the churning temperature. By this means it is possible to control the ripening of cream exactly to suit the requirements of whatever market the butter is placed on. It is not an unusual occurrence for bacterial contamination to take place in the subsequent manipulation of the butter, but with reasonable precautions and proper appliances this can very easily be avoided, and perhaps the most common source of danger at this stage is from the water used for washing the butter. Tank water at the end of summer is, without exception, bacteriologically impure, and though it may be harmless for domestic purposes, is altogether unsuitable for the dairy. If it must be used, it should first be passed through a steriliser, and afterwards cooled, but deep well water neither sterilised nor filtered is quite pure enough, and from an economical, as well as every other standpoint, the most preferable. Personally, I am strongly in favour of pasteurising all the year round, and it is absolutely indispensable to the manufacture of choice butter at seasons of the year when grass is rank and plentiful. I feel sure that if pasteurisation was universally adopted, we would hear less complaints about Australian butter being 'off' flavour on the home market, and with a uniform quality, people would acquire a taste for it, which in time would gain a standing on the London markets on its own merits, like the Danish. At present the very best Australian butter is seldom retailed on its merits, being frequently blended with English or Irish, and sold as best 'English Mellow.'

"I feel confident, however, that under all conditions of climate, and other circumstances, if each day's culture is propagated in carefully pasteurised skim milk, the result will be as I have proved it in practice—an unqualified success. There are two very strong reasons in support of this method, the strongest of which is that in the event of one day's cream going slightly 'off,' as it will sometimes do, the fault is not transmitted to the following day's make, as each day's cream is ripened with a perfectly fresh culture; in this way the origin of a taint may be stopped before it is even noticeable in the cream or butter. On the other hand, if buttermilk is used to carry on the culture, it is not only possible, but highly probable, that the taint will be intensified from day to day, until eventually the quality of the butter must be depreciated. The other reason in favour of skim milk being used is that it is a much better media for cultivating the organisms that bring about lactic fermentation than cream, and by carefully regulating the temperature the percentage of acid can be kept perfectly uniform ; but cream, on account of its variable percentage of carbonaceous compound, which is used by lactic bacteria, is liable to have a different acid percentage every day ; therefore it cannot be depended on to ripen the cream uniformly. The temperatures at which lactic cultures are grown must be modified to suit the different seasons of the year, and the milk from cows at the end of the lactation period, which has a decided salt taste, should be excluded from what is used for propagating the culture, as the salt acts antiseptically on the organism and prevents its development. I have had considerable trouble from this source, and found all remedies unsuccessful until I picked milk from fresh calved cows, which had the effect of immediately bringing the culture back to normal conditions. It is hardly necessary to state that without thorough sterilisation of all utensils, pasteurisation cannot be successful."

Pure Cultures

One of the objects in publishing this book is to show how very desirable it is for every country to produce a uniform high-class flavour in dairy produce. A good deal has already been said on this subject, and some elements of vital importance have been exhaustively dealt with in the preceding pages. The value of a starter cannot be over-estimated, and each year provides additional evidence in support of its use. But a word of caution is necessary, as serious errors have resulted through the use of starters by careless and incompetent persons, with the unfortunate result that in some cases the starter and the whole practice have been openly condemned. The marketing of old and worthless starters is also to be regretted.

A pure culture should be prepared by those skilled in bacteriology, as the greatest possible care is necessary, otherwise the consequences would be serious. The bacteria of pure cultures may be said to be indigenous to the different countries in which they abound. For example, in New Zealand, Australia, Denmark, Britain, and the Near East, ripening cultures possess their own peculiar and distinctive properties. This is attributed to the climate and conditions of life of the bacteria. In a country with a dry and warm atmosphere in summer, and cold in winter, the choicest of lactic bacteria invade the dairies and produce most excellent flavours in milk products. In the Balkans this was demonstrated to the writer in a very forcible way, and perhaps no countries in the world can produce more attractive flavours in dairy produce than is found in Bulgaria, Servia, Roumania, and other Balkan States. In these regions there is a natural purity in the air, and lactic organisms of a choice breed seem to predominate everywhere. The question arises, Can pure cultures be transported to other countries of different climatic conditions and reproduced in the dairy with the same success? The writer has good cause to say it is not possible. Nature has in this instance achieved what science is not going to meddle with too freely. This takes us to another feature of our subject, too important to be overlooked, namely, the quality of the milk to ensure the best results from cultures. Native breeds of cows that roam about the Balkans, and feed on nothing but the natural herbage for seven months of the year, yield milk of very high keeping qualities. This was proved in comparative tests with the milk from British cows, which were kept under the same conditions as the native breeds. It therefore follows that a relationship exists between the bacteria of a country and the native milk supply, and that the composition of the milk is a factor of greater importance than is at present understood. From the writer's observations the deductions to be drawn are that the preparation of pure cultures in any country should be from the best class of lactic bacteria found in the country, and the aim of the bacteriologist should be to increase their value by growing them under the most favourable conditions.

Acidity and Flavour

Obtaining the so-called "proper degree of acidity" is not sufficient in modern butter and cheese making. But unfortunately this does not seem to be understood or appreciated. There are different qualities of almost everything that exists in commerce, or in nature, and there are also different qualities of lactic acid in dairy products. The degree or strength may be quite satisfactory, but the acid may be inferior. In perfumes we have, for example, an expensive and a cheap quality of violet. The expensive has a marked superior bouquet—a delicate, choice aroma, as the butter-maker would express it—while the cheaper perfume is harsh to the sense of smell. This may be applied, although in a somewhat different way, to the lactic acid flavours in cream. When cream ripening is perfect the aroma and taste of the product is very delicate, clean, and thoroughly agreeable. Again the same percentage of acid may give a flavour that at once displeases. There will be no aroma; that term will be displaced by the word "smell," which is substituted to indicate an inferior change.

In margarine manufacture, which is dealt with elsewhere, it has been shown that the animal and vegetable fats from which margarine is made are "ripened" with a butter culture, and for what reason? To impart a choice flavour to the product, thereby enhancing its value.

Differences in the quality of the lactic acid of milk and cream were in a very striking way illustrated to the writer abroad. In a country where the native dairymen excelled in milk preparations the aroma was so delicate, and the taste so inviting, as to suggest the inoculation of the milk with a chemical of an exceptionally choice flavour. This, however, was far from being the case; it was entirely due to the successful cultivation of a particular class of lactic organisms. What is desired to show to readers is, that in the ripening of cream pure air is absolutely imperative to the healthy growth of the organisms, and as they give off gases like the higher plants, aeration of the cream is also necessary to admit of the escape of the gases. The value of a free circulation of air in cream-ripening rooms will now be better understood, and a system of aerating the cream before it goes to the ripening vats, and its gentle movement there by the agitators, will be more fully appreciated. Experiments conducted by the writer showed that the use of electric fans in cream-ripening rooms gave very excellent results, by improving the flavour and keeping properties of the butter.

Preparing the Starter

Preparation of Milk.—After thoroughly cleansing and sterilising the vessel, add one gallon of sweet separated milk. This is pasteurised, preferably by the intermittent process, which is as follows: Heat the milk to 190° F. for ten minutes; leave to cool for one hour or more, and again heat to 190° F. This not only destroys the ordinary class of bacteria, but many of the spores are killed or rendered inactive. The milk is then cooled to 100° F. by placing the vessel in cold water, afterwards it is put into the starter pail, which has been thoroughly cleaned and sterilised by live steam. The best kind of vessel to use is a white enamel pail of about two gallons capacity.

Adding the Starter.—The next step is to inoculate the milk with the pure culture. The bottle containing the culture is carefully emptied into the pasteurised milk. The milk is stirred with a spoon that has been sterilised, and care is taken to prevent contamination from the air. The vessel is covered with a sterilised muslin, and put in a room at a temperature of about 70° F. After 2 or 3 hours, when the temperature of the milk has fallen, it should again be raised to 100° F. In 20 to 30 hours the milk will be sour and coagulated.

This high temperature of inoculation is desirable, because the germs in the pure culture may be somewhat dormant, and by the extra warmth their growth is hastened.

Propagation of Starter.—In a can that has been thoroughly cleaned and sterilised place some new sweet separated milk, heat to 190° F. for ten minutes, leave to cool for one hour or more, and again heat to 90° F. Put the can in cold water, and cool to 75° F in winter and 65° F. in summer. After the starter has been skimmed, add to the pasteurised milk from 2 to 5 per cent. of the previous day's preparation. Thoroughly stir the milk, cover with a sterilised muslin, and leave in a suitable temperature. In 18 to 20 hours the milk should be acid and thick. It is recommended to propagate the starter for two or three days before it is used for ripening cream for butter-making, or milk for cheese-making. When a starter is first prepared, it has an undesirable taste and smell. This is eliminated by acting as suggested. A uniform starter can thus be prepared from day to day, always adding enough of the starter from the previous make to the pasteurised separated milk.

Home-Made Starter. —In many countries the isolation of dairies makes it difficult to get pure cultures for the ripening of cream and milk for butter and cheese making. In such cases the selection of a dairy or factory noted for its exceptional quality of produce should be made. A quantity of buttermilk from a particularly choice churning should be secured and used to produce a starter. All conditions must be observed to ensure as pure a ripening product as circumstances will permit.

Cream Grading and Ripening

The commercial success of a factory is largely in the hands of the cream grader, and this will now be fully appreciated by readers. It is the grader who distinguishes between a first and a second class cream, and that which is unfit to be mixed with either class. He, and he alone, is responsible for the quality of commercial butter, and not the butter-maker, who is largely entrusted with the mechanical part of manufacture. In the equipment of modern factories there should be sufficient ripening vats to receive the different grades of cream, and every convenience provided to enable the work to be carried on, without hindrance of any kind. This subject is further dealt with in Chapter III.

The keen observance and attention of the grader should be directed to the proper mixing of cream in the vats, so that an even ripeness will be obtained, no part of the cream showing more or less acid than another. To effect the successful ripening of cream requires the mixing to be done the day previous to churning, a steady temperature, a pure atmosphere, and a gentle agitation in the vats.

When the proper degree of acid has developed, and the product is ready for churning, the flavour should be pleasantly sharp, followed by a little sweetness. When over-ripe the sweetness disappears, and a harsh acid predominates; if under-ripe, the acid flavour will be weak and the sweetness marked. Using the acidity test, 0.35 is a safe ripeness for export butter, particularly if a flavour known as fishiness is troublesome at the factory.

Only to the cream grader should the ripening be entrusted. He will control his vats by artificial cold and mechanical means, producing the correct degree of acid for each day's churning.

We have referred to choice ripening organisms being indigenous to a country, or in other words, in every country or part of a country a particular variety predominates, each having well pronounced properties. In warm, swampy districts lactic organisms are very active, but they produce a somewhat inferior acid, which may be attributed not only to the climate, but to the slushy condition of the milk. Immature food, influenced by a muggy climate, will produce immature milk, and a degenerate class of lactic bacteria will predominate. Through this cause the acid will be inferior, and bad flavours more troublesome. Again, the breed of cattle will influence the acid-making bacteria. Poor milk will give a higher acid reading than milk rich in fat, and the lactic flavour will be more attractive, providing all conditions are properly controlled. We have in the milk of goats, sheep, and in the milk of the mare, a marked variation in the percentage composition, and if the same culture were used to produce ripeness, different results would be obtained in each case. Also with different milking breeds the same applies, although to a much lesser degree. We are told that the milk of the Ayrshire cow is best for cheese-making, because the fat globules are small, but in addition to this, the milk is possessed of properties which are specially valuable from an acid standpoint. If we take a dish of Ayrshire milk and a dish of Jersey milk, both fresh from the cow, and allow them to coagulate in a natural way, it will be observed that a firmer curd is obtained from the Ayrshire milk, also a higher acidity. The same will follow when rennet is used.

The milk of the Jersey cow is proverbial for quality, and the fine waxy texture of the butter is highly prized, but it is questionable if a choice lactic flavour is more characteristic in the butter of the Jersey breed compared with that of other dairy breeds. It is more creamy or fatty, and it is known to practical men that butter fat will give a sweet, inviting flavour to fresh cream.

Culture from the Air.—It has been written in this book that lactic germs abound in the air of the cleanest dairy, and the more cleanliness shown the more likelihood there is of obtaining a purer class of organisms for souring the cream.

By exposing a plate containing culture media to a "choice" atmosphere a pure culture of bacteria will be obtained that will produce a choice flavour and aroma in dairy produce.

Farming for Flavour

Quantity and quality of milk is the sole aim of the average dairy farmer. If he is growing milk for the city, quantity will claim closest attention. For butter and cheese making the question of flavour is of vital concern. Too much has been claimed for pure cultures and starters, with the result that one is invited to believe that a choice flavour can be instilled into raw produce of inferior quality with absolute success. Without doubt "flavour" is neglected by the industry of dairying. Science frequently overrules practical reasoning.

In the selection of a dairy farm, the production of high-class produce should be carefully considered. Who would, after serious thought, rent property, unless at a very low figure, that is low-lying, water-logged, and is climatically antagonistic to a good flavour and body in butter and cheese? Should all this not be considered under the title of flavour? Might it be queried what is the difference between the profits of a heavy yield of milk in the manufacture of produce of poor flavour or secondary quality, and the manufacture of produce from a smaller yield of milk, but with a superior flavour and a higher keeping quality? The results would clearly show that the future dairyman will have to study practical features that are associated with the flavour, texture, and keeping properties of his produce. The following is a summary of the chief conditions which are responsible for flavour in the raw and manufactured produce of the dairy.

District and Climate	Atmosphere	A dry atmosphere favours a useful and healthy class of bacteria. A clean atmosphere gives a predominance of "pure cultures." Temperature is a controlling agent in their numbers.
	Soil	"Dirty" soil breeds hurtful germs. "Cleanliness" of soil makes a healthy seed-bed for bacteria which invade the air. Healthy soils produce healthy herbage.
	Water	Impure drinking water for dairy cows lowers the ripening qualities of milk. Stagnant water in the soil produces herbage that gives a similar result.
	Food -	Matured food raises the texture of milk and provides a better basis for the manufacture of choice lactic flavours. Food also produces flavours which injure those arising from lactic fermentation, and food produces its own choice flavours and aroma.
Cows	Breed	Breeds and individual cows may be said to raise or lower the natural value of milk for lactic fermentation.
	Health	Unhealthy cows will lower the flavour and keeping properties of milk and dairy produce by unfavourable changes in the formation and composition of the milk. This class of milk will give a bad seed-bed for ferments.
	Lactation	At the beginning and end of lactation, milk is abnormal, and is fatal to good flavours. Hurtful classes of bacteria thrive in the milk.
	Treatment	Gentle treatment of cows will increase the value of the milk for choice flavours. Regularity in milking will do likewise.

It should be observed that physical changes and enzymes are associated with milk flavours.

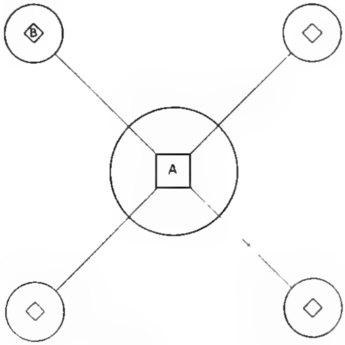
Dairy Research

All dairying countries should devote sincere attention to this branch of science. There is an immense amount of very valuable work awaiting the research scholar. Our knowledge of some flavours is very elementary. It is suggested that efforts should be directed to classify the good and bad flavours of dairy produce, taking the following as a guide:—

	Good Flavour.	Bad Flavour.
Described as	Lactic.	Rancid.
Produced by	Lactic organisms.	Butyric organisms.
Chief source	Clean surroundings.	Dirty surroundings.
Nature of food supply -	Sugar.	Proteid matter.
Propagating and controlling temperatures -	45° to 85° F.	10° to 70° F.
Period of activity	Comparatively short.	Months.
Dependent or independent	Independent.	Dependent on other bacteria.
Free or otherwise	Free.	Partly free.
Fixity of flavour -	Temporary.	"Permanent."

In the list of flavours we have lactic, creamy, "nutty," fruity, vinegar, bitter, sour, rancid, stale, cowy, musty, woody, tallowy, weedy, fishy, salvy, oily, greasy, metallic.

In a number of ways flavour and texture of butter and cheese have a marked relationship, and it might be suggested that the dairy research departments of different countries should work conjointly to unravel flavours that are the same and equally destructive to the produce of each country. Of the question of free flavours we know that at stages in the life of bacteria of dairy produce, the product of certain classes can be washed out of butter. The removal of flavours by this means is only effective when the activity of the organisms is directed against the more soluble constituents of milk. There are flavours that cannot be washed out, because they have been fixed by the organisms amongst the butter fats, which is the source of the food supply of the bacteria. Tallowy flavours may be taken as an illustration. To eliminate this resistible class from butter the process known as renovating is followed, and which is very successfully and profitably practised in America and other countries. The duration of the life of dairy bacteria and their dependence or otherwise on other classes of organisms is a question of special interest and value to the dairying industry. There is also the subject of moulds to be more closely studied. It may not be generally understood that some can flourish in the presence of boracic acid, but it is not known what conditions favour the moulds to resist the action of the preservative. Further, the flavour of foods and the part they play in giving to butter and cheese attractive properties have practically been omitted from the curriculum of the scientist and investigator. What appears to be urgently required in dairying countries is a State dairy farm conducted in conjunction with a school, factory, and research department and established in the most prominent centre of the industry. This institution would be the controlling factor in scientific work, and affiliated with branch research laboratories of other educational bodies. Such an arrangement would prevent clashing of results, as all reports and decisions in connection with investigations would emanate from the central authority. An institution of this kind would cost much, but it would pay the country handsomely. This suggestion is illustrated as below on the principle of the central butter factory with its auxiliaries or feeders in the less important districts.



A. Central Laboratory. B. Auxiliaries.

CHAPTER III

BUTTER PRODUCTION

Erroneous Ideas.—It is said that the successful churning of cream into butter is an art that requires great practice and skill. Further, we are told that some people have never been able to master the difficulties of the churn and worker, hence their failure to manufacture a choice product. All this is incorrect, and usually arises from sources far back in the history of dairying. It is true, care and intelligence are imperative in practical butter-making, but the ordinary worker may acquire the necessary knowledge in a season or two, and be capable to thoroughly manipulate all the appliances of an up-to-date factory.

It is not the intention of the writer to go into the mechanism of the subject, as the only way to fully understand the machinery of a butter factory is to have experience of its use. We shall at first give attention to the construction and general equipment of a factory.

Constructing a Factory.—Before the plans of a factory are prepared the selection of a site is made with the greatest care. Very close attention is given to situation, drainage, water supply, and climate. The writer has been associated with many eminently successful factory enterprises in tropical parts, and under all conditions of climate. The advance of science in the construction and equipment of factories has practically mastered the vagaries of the weather, but such vital elements as drainage and water supply should have a sound natural connection, to avoid costly and more or less defective artificial systems. Failures through this cause have often been attributed to factories, particularly in hot countries, where decomposition of milk products is rapid and destructive.

Having imaginatively selected the site on rising ground, we now proceed with the plan of the factory. If our work is being conducted in a warm climate, provision will have to be made to have that part of the factory of least concern facing the hottest direction, and the most important section to face the cool winds. If the site has no natural shelter, provision is made by planting a belt of trees, having a vigorous and bushy growth, and capable of reducing the hurtful effects of the hot winds. Height of the walls, drainage, light, insulation of the butter-making and cream rooms, call for special attention, likewise does the material used in the insulation of the walls and construction of the floors. For the latter, impervious material, such as lead and tile, is essential, and in every department of the building the most serious consideration will be given to minimise dangers from microbe life. Under such conditions a system of drastic cleanliness can be attained without the slightest difficulty, and with the least injury to the material. The situation of the various rooms will be convenient to minimise working expenses, and compactness will be studied to bring all valuable space under the economic influence of the refrigerator, without in any way reducing efficiency. The situation of each room will be carefully thought out, and the closest attention paid to the cream-ripening department. The draughtsman will give enough light to this room as experience has shown to be necessary; ventilation will be perfect, and a circulation of air provided to carry off odours and gases that escape from the ripening vats. The vats will be conveniently situated above the churns, and each will be simple in construction, easy to clean, and equipped with the most modern combined agitator and cooler. The vats will, therefore, be kept under perfect control for regulating the temperature

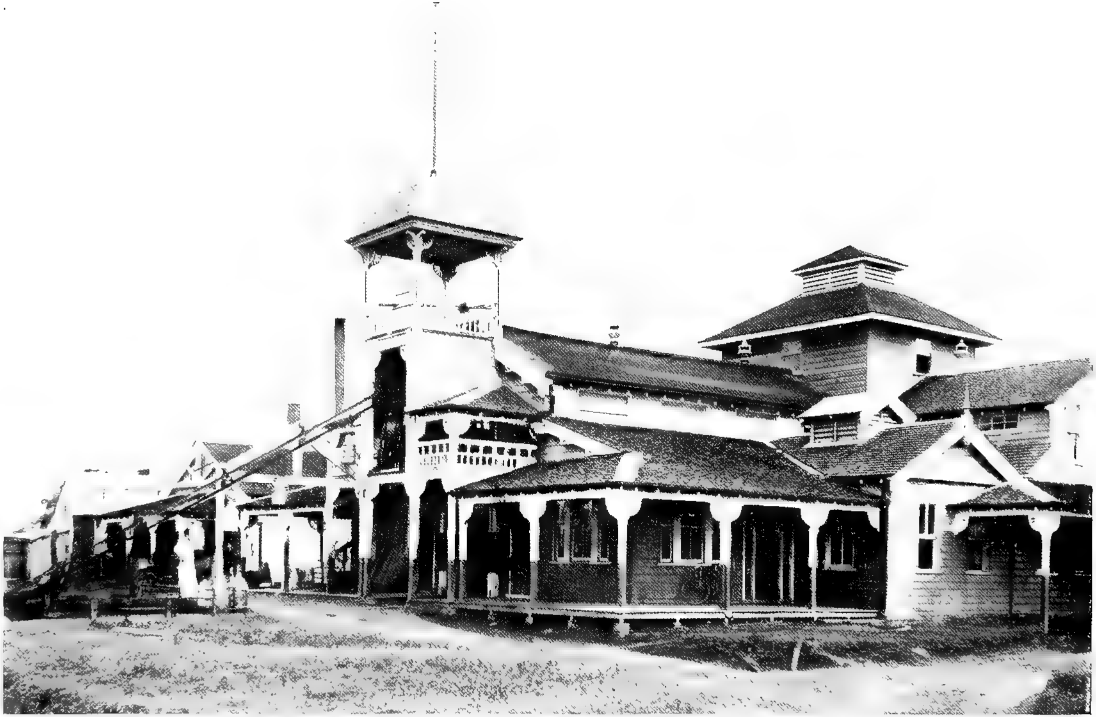


FIG. 10.—Grafton Butter Factory, New South Wales.

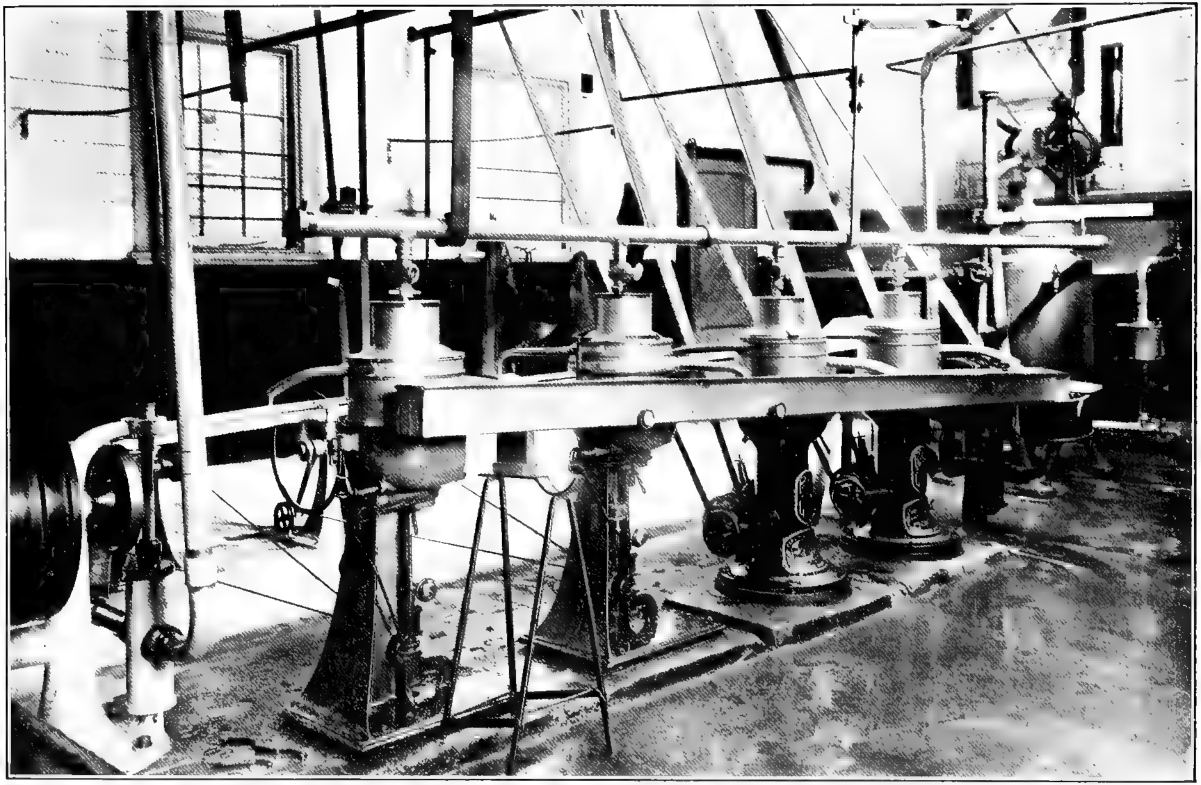


FIG. 11. Separating and Pasteurising Plant in a New Zealand Butter Factory.

during the ripening of the cream. In the cream-receiving room simplicity will be found, as it should be everywhere.

The cream pump will show few joints to interfere with thorough cleansing, and there will be no harbours or hiding-places in which matter can decompose. In the butter-making room a cool and steady temperature will be maintained in the hottest of weather, all the walls being thoroughly insulated, and the atmosphere completely under refrigeration. Churns will be so constructed to give the best results, and the butter-workers strong and easy to clean. The mechanism will be of the simplest, and the design of the rollers will offer no cause for criticism and ridicule.

Slate or marble tables will be provided, and a power printer to throw off its thousands of pounds of butter per hour, also a power packer for 56-lb. boxes.

Adjoining the butter making room the refrigerating chambers will be found, where butter will be stored at temperatures that will prevent rapid changes of flavour. All the work in the well-equipped factory, such as described, will be quiet, quick, methodical, and in accordance with the laws of science and practice. We are considering a commercial enterprise, worked in the face of healthy competition. But the architect and contractor of a modern factory does not finish with what has been written; his training and observation compel him to attach grave importance to the situation and equipment of the testing room. Here one will find the steam turbine, Babcock apparatus, the acidimeter, complete appliance for testing the water content of butter, and other requisites indispensable to work which devolves upon the management of such an enterprise.

Look as one may, the up-to-date factory laboratory is not tarnished with antiquated utensils that give inaccurate and misleading results. This cannot be said of all schools and teaching centres, where one should be able to inspect the latest scientific inventions of the world in the testing and examination of dairy produce for commercial and educational purposes.

It is here where the cultures are prepared for the making of starters, which are indispensable to the ripening of pasteurised cream, and it is also here where the decision is given as to the amount of money to be paid to individual suppliers, based on the fat content of the raw produce.

Arrangements will be made at the factory for the washing of vessels, and a row of jets will be seen over which the clean vessels are subjected to a high pressure of live steam, also there will be the modern "feed water heater." When all is finished for the day, in such a factory the careful manager will be in a position to give the wooden appliances and utensils a last bath in lime water.

Churning.—For factory use the old-fashioned churn gave place not many years ago to the box pattern; now the combined churn and worker is preferred by many factories. We shall describe the general process of churning and working, omitting parts of the subject that have been dealt with in previous chapters; also it is necessary to point out to readers that additional matters of importance to churning will be explained in describing the defects in butter.

After the churn has been scalded and cooled down, it is charged with cream from the vat overhead. The churning temperature best suited to the ripeness of the cream, season of the year, and other conditions referred to elsewhere, will have had the grader's and the manager's very careful attention. It may, however, be said that 48° F. in the summer months is a satisfactory average. He will specially guard against a soft grain and texture of butter, which experience has shown him to be injurious to the finished product, and that no after treatment by cool temperatures will counteract the bad effects.

Colouring.—We arrive at a stage in which the butter is coloured to meet the demands of district and market. A primrose tint is generally preferred in Britain, but there are counties in England that give a decided preference to a high-coloured product. The best preparations of annatto should only be used, otherwise a cloudy or discoloured condition of the butter may be caused. The natural colour of butter is influenced by the following conditions:—

Breed and individuality of cow.
Feeding. Spring butter is higher in colour.
Ripening of cream.
Churning temperature. A high degree reduces colour.
Temperature of water and period of washing.
Duration of churning.
Salt and exposure to a pure atmosphere and subdued light deepens the colour; bright light bleaches.

After the colouring matter is added, the churn is set in motion, and the attention of the butter-maker is required to liberate gases which escape from the cream. This is called "ventilation." Ferments chiefly produce the gases which add to the atmosphere in the churn, causing a certain amount of pressure on the movement of the cream. This action is of considerable interest, as it demonstrates the necessity to gently agitate or stir the cream during ripening, when germ gases and odours are replaced by a sweet atmosphere so essential to perfect ripening. Ventilating the churn must be done after the first few revolutions, and continued at short intervals until no escape is felt. If this were neglected the gases and odours would be retained in the cream, and a sleepy condition caused; also other injuries would follow. While the churn is in motion interesting physical changes are taking place—the movement of the cream is causing it to separate into two different bodies. The globules of fat unite, forming specks of butter, and the other solids of the cream, including lactic acid, remain in the buttermilk. Success of this change depends upon the spontaneous liberation of the fat, which is governed by the distribution of the acid in the cream. The acid coagulates and partly digests the solid matter, giving to the fat a free and simultaneous escape, which to butter-makers is known as the breaking of the cream. It should be carefully noted that these changes have a softening effect on the fat, and by reason of this the butter-maker checks the gathering of the particles by the addition of cold water to the churn. A few revolutions will bring the grain to the desired size. The buttermilk is now drained, and replaced by an abundant supply of chilled water, which has the advantage of firming the butter particles, and helping to fix the flavour. If all stages in churning have been satisfactory, the butter grains after washing will be regular in size, glossy in appearance, and firm and velvety to the touch. The butter will have a sweet, mild, creamy flavour, and nothing else will be imparted to the palate. The churn is now tipped sufficiently to allow of the removal of the butter to the worker.

Butter-Working.—Workers should be constructed to afford the thorough drainage of moisture that is expelled from the butter. The rollers ought not to be too high from the table, which would give insufficient pressure when treating small quantities of butter. Provided with springs the rollers will yield to pressure, and no damage to the texture will result. The old-fashioned three-fluted roller is very injurious, causing greasiness, and if the butter is not free from milk it becomes incorporated in the product.

When butter is put on the worker from the churn, it should be exposed only to a few turns of the roller to expel the free moisture. If this is exceeded the good influences of salting will be withheld.

Preserving Butter on the Worker.—The treatment of butter with salt and borax compounds should receive more care than is customary. On no account should the preservatives be sifted on the butter in irregular quantities. This will cause not only defects in texture, but the flavour may turn out to be irregular through their uneven distribution. For further particulars on the treatment of butter, see pp. 125-28.

Washing Churns and Workers.—Immediately after use, churns and workers should be washed in slightly warm water, afterwards scrubbed with salt or soda and cold water, and then thoroughly scalded and dried. Before using again, scalding and cooling are necessary. After this treatment utensils should have no bad odours, and greasiness of churns, workers, and wooden hands should not be a complaint. All appliances are benefited by a soaking in hot lime water.

Combined Churn and Butter-Worker.—This machine is coming into prominence in different dairying countries. It is taking the place of the barrel and box churn and butter-worker, principally owing to the convenience of manipulation, and the small space it occupies, which are very important factors where there is a large turnover of butter. The present objection to the combined churn and worker is the difficulty of thoroughly airing the churn, hence the greater liability to musty flavours developing in the butter through contamination from the wood. This, however, may be thoroughly overcome by the use of specially prepared aluminium, with which the inside of the churn is lined, also the worker, and there is not the slightest danger of the butter sticking to the metal. When aluminium is not used the churn and worker should be made of the very best quality of hard and seasoned wood.

Another point which cannot be overlooked is the very great care that is required in preserving the grain, there being a tendency of the butter particles to gather in lumps. By a better control of the temperature of the cream, and churning at a lower degree than is generally practised, this difficulty is largely met.

Butter from Factory-Handled Milk

In the preceding pages we have fully considered the manufacture of butter from cream delivered at the factories by suppliers. This system is commonly followed in Australia and other countries. In many parts of the Commonwealth the scattered districts and the long distances between the farms and the manufacturing centres have made it a necessity. It is unfortunate for Australia that a greater effort has not been made to establish separating stations throughout the dairying districts where milk could be treated, thereby ensuring a fresh and sweet supply of cream for the factories. In Africa, and other parts of the world where dairying is coming into prominence, great care in this direction should be exercised, although difficulties will be met with similar to those in the Commonwealth. In Denmark we have an example of a country that has taken the fullest advantage of the possibilities at her command in the manufacture of uniform high-class butter. The factories have complete control over the milk and cream supply. Nothing but sweet cream is handled, and, as already explained, this is pasteurised and ripened by a starter. To a lesser extent this practice is followed in New Zealand, and since pasteurisation became more general in that Dominion, the quality of the butter has improved.

Farm Butter-Making

The practice outlined here will be for use in Britain, but the principle applies to all countries, only modifications are necessary, as climatic and other conditions demand.

The object of the dairy farmer should be to put on the market butter of a quality that will not only please the grocer, but, of more importance, please the customer.

If this were done a higher price would be paid for the produce, which would more than compensate the farmer for the additional care and attention given to manufacture. One has to admit that British farmers have been working in opposition to their own interests. They have not co-operated in their respective districts for their own protection and benefit. To make butter on the farm of a quality to compete with the choice brands that are imported, one must keep apace with the times, and that is to adopt as far as practicable modern methods and teaching. It is the farmer with capital who should initiate this progressive step, not the man who is struggling to make ends meet; he should have the practical education brought to his home, as this book shows to be necessary. Unfortunately, butter-making in England is said to be a waste of energy; but surely that does not apply to every county, where the price of butter is quoted for the average winter season from 1s. 4d. to 1s. 6d., and in exceptional cases 1s. 8d. per lb. is paid.

The following instructions in butter-making should be practised wherever possible; at the same time readers will understand that very good butter can be made without pasteurising the cream as suggested. But circumstances compel us to bury our prejudices and ideas, and to make butter that has not only a fine aroma, but long keeping properties.

Treatment of Cream.—For farm butter-making, cream is heated to a temperature of 160° F. to 165° F., and while this is proceeding it should be kept in gentle circulation. It is afterwards cooled to about 60° F. in summer, and in winter to 75° F. Following the destructive action of heat on germ life in the cream, it is necessary to add a starter to ripen the cream for churning. The proportion used is governed by: (1) The period the cream is to be kept. (2) Consistency of cream. (3) Season of the year. (4) Temperature.

(5) Activity of the starter. As a rule, from $2\frac{1}{2}$ to 5 per cent. is used in summer, and from 5 to 8 per cent. in winter, for twenty-four hours' ripening. The cream requires to be stirred frequently during ripening, and should be kept at a temperature of about 60° F. in a room having a free circulation of air. In hot summer weather efforts should be made to get the temperature lower than this, and it is recommended to place the vessel of cream in cold water. In winter, care is necessary to prevent the temperature from getting too low, or bitterness is likely to be caused by slow ripening. Precautions should be taken to have the cream of a proper density, for reasons given in Chapter II.

Thinning.—The ripened cream, being too thick for churning, is diluted with water to the proper consistency, a simple test to ascertain this being the free movement of the cream from the wooden hand. As it is necessary to churn at a fixed temperature the water serves two purposes. If excess of water is used the cream will be slow to break, and if too little it may go to sleep.

The cream should now be strained to prevent unevenness in the grain, which is caused by the formation of lumps during ripening. Sufficient colouring matter is added to meet the demands of the market.

Churning Temperature.—Accepting 57° F. as the mean temperature of the making room in Britain, the cream is generally churned a few degrees lower, and in the winter months a higher temperature is necessary. Owing to the different agents that influence the churnability of cream, the temperature should be arranged so that the cream breaks in from 15 to 25 minutes.

Breaking Water.—When the particles of butter begin to appear on the observation glass, water is added to keep the grains separate, and to cool the churn. The temperature is from 4° to 6° F less than the churning temperature, and a little should be added at a time in case of checking the gathering of the grains. If the grains are inclined to run together too quickly, decrease the temperature of the water. The grain should be about the size of No. 5 shot.

Washing Water.—This water is generally from 6° to 8° F. lower than the churning temperature, and the quantity used should correspond with the yield of buttermilk from the churn. It should be ready to add immediately the milk is withdrawn, afterwards the churn is revolved a few times.

Second Washing Water.—Brine is used as a second washing. The following advantages are claimed for the practice :—

The butter grains become fully exposed to the fine flavouring effects of the salt, and the keeping properties of the butter are increased. Temperature is lowered, and buttermilk that has escaped the previous washing is more likely to be expelled. Butter will be salted more evenly, it will be firmer, and of a better colour, and the weight increased. The quantity of salt deposited in the butter depends upon the size of granules, the time exposed to the brine, and the dryness of the butter when removed from the churn. Brining at the rate of 2 lb. of salt to the gallon of water will deposit in the granules about 0.25 of 1 per cent. of salt at the end of thirty minutes. Fifteen minutes' brining is generally recommended. When the brine has thoroughly dissolved it should be passed through a muslin into the churn, and the churn turned for about half a dozen times to incorporate the brine with the grains. Care should be taken that the grains adhering to the lid and sides of the churn are washed down in order to benefit from the brine.

Working the Butter.—After scalding the worker and cooling it with fresh cold water and salt, it is ready to receive the butter. In working, particular care is necessary to prevent damage to the texture The free water from the butter should be mopped up lightly between each working with a piece of muslin. For the unskilled person it is better to roll up the butter with the Scotch hands, instead of reversing the roller, as this requires practice. Dry salting is explained elsewhere.

Assisting the Farm Butter-Maker

It is strongly advised in this work that practical dairy instruction should be brought to the farm. There one will not always find the ice that is recommended for use in hot weather, and, faced with defective buildings, the farmer cannot easily control temperatures, which play so important a part in successful butter-making. With these and other handicaps common to the average dairy the farmer should not, however, turn his back on teaching centres, for he must remember that it is the duty of all schools to illustrate a perfect system of butter and cheese making, and as much of the instruction as conditions and circumstances will admit should be adopted. If dairy associations were formed throughout Britain, and were affiliated in some practical way with dairy schools, permanent good would result.

Let us see what we can suggest to assist the farmer to overcome some of the difficulties of modern butter-making, chief among them being the question of temperature. In making his proposal clear, the writer will refer to his own experiences as a Dairy Adviser in South Australia. In this particular instance, the farmer was a German, and the district was essentially of the same nationality. He was very ambitious and intelligent, but poor, and his great wish was to carry off a prize for butter-making at a leading agricultural exhibition. The German colonist solicited official help, disguising the fact that the butter was to be used for show purposes. A few written instructions were sent to the farmer as to milking and separating, and on a certain day the writer arrived at his homestead to instruct in the ripening and churning of the cream. "We are up against difficulties," the farmer said, "for I have no ice, neither have I cold water." The day was scorching, the thermometer in the shade being over 100° F. We adjourned to the cellar where the cream was kept, and luckily the temperature was between 70° and 80° F. The product was fresh and sweet, and we pasteurised it to 150°, using the washing boiler for this purpose. The cream was then aerated by running it over a curved sheet of galvanised iron, and now we encountered what was considered our greatest difficulty, but which proved to be readily overcome, viz., lowering the temperature of the cream. A perforated pipe, blocked at one end, was got ready, which we had connected with an overhead water tank. Two sheets of canvas were fixed to the pipe in such a way as to have both sides thoroughly saturated with the water. After the cream was inoculated with a home-made starter it was put into a number of small cans, and each was given the full benefit of the wet canvas. A hot wind played on the canvas all afternoon and night, and by 4 A.M. the next morning the cream was down to 60° F., and at six o'clock 55° was reached.

A supply of cold water was got from a neighbouring well, and the butter was successfully churned, although the texture was rather soft. It was put in a large earthenware crock, and lowered into the farmer's well for a couple of hours till the texture was firm enough for working and salting. A second cooling was found necessary, after which the butter was pounded, papered, and packed. To the writer's surprise the butter was exhibited at the State National Agricultural Show, and won the highest award. So encouraged was the German with his success, that he sank two new wells, one for cold water, and one specially constructed for cooling the cream. He also erected a substantial cooling apparatus on the lines explained in Chapter I., and he covered all the cream cans with canvas envelopes. On a future occasion, and without any assistance or advice, further honours were gained by this German at the same exhibition, and finally he won a high award for Colonial butter at the London Dairy Show.

Another striking illustration of improvement in butter-making will be given, but in this case it emanated from the lecture hall. The farmer in question had all along earned a good name as a competent butter-maker, and the price obtained for his produce was evidence of its good quality. But the farmer was not satisfied, as he believed that improvement could be made in his methods, and even better prices realised. With this laudable object in view he attended a winter course of lectures in the practice of dairying given by the writer at Adelaide, South Australia. At the close of the session the farmer was a fortnightly visitor to the Government dairy laboratory, bringing with him samples of cream and butter for testing purposes. Examinations were made of the samples, and, during his visits, the farmer did good work in educating himself to judge the acidity of cream. In due time he was able to thoroughly control the development of acid, and to churn at the most profitable stage of ripeness and temperature, thus securing the best flavour in the butter with a minimum loss of fat.

Bacteriological Cultivation of Cream and Butter.—Readers are now aware that injury to dairy produce is chiefly brought about by the activity of germ life, and in searching for the cause of taints it is customary to grow for examination the many kinds of organisms contained in the product. Throughout the months occupied in testing the farmer's cream and butter, germ invaders became less numerous, and ultimately a very choice product was obtained, as shown by the grading of the butter :—

	Flavour.	Texture.	Total.
Maximum points	60	40	100
Awarded	59·5	40	99·5

A second test was made fourteen days after the date of manufacture, and the flavour was so well maintained that only 0.5 was deducted from the previous total.

How the Butter was Made.—The following particulars were given by the farmer :—

1. The cows are fed twice daily on a chaff and meal ration, moistened before feeding.

2. The udders of the cows are washed and dried before milking (winter months, or wet season).

3. The cream is separated immediately after milking, night and morning.

4. Cream collections are made in 1 gal. quantities, and sixteen hours before churning all the cream is mixed together to allow of an equal distribution of acid. Stirring is done at intervals.

5. Ripening is so regulated that at churning the cream is acid and sweet to the taste, and the flavour attractive.

6. Churning temperature is 58° F. (winter time).

7. Cream is churned into grains.

8. After one washing the butter grains are brined in a solution of 5 oz. of salt to 1 lb. of butter. No dry salt is used.

9. The butter is worked once.

The farmer stated that the brining was a great advantage as little working was necessary, and no crystals of salt were noticeable on the surface of the butter or paper as previously occurred. His experience went to prove that the extra cost for salt was well repaid in the advantages gained by the practice.

In an analysis of the butter the following percentages were found :—

Fat.	Water.	Melting Point.
87.13	10.01	87°

The above illustration would be termed theoretical by some people, but that would not be a true interpretation. It is the example of the alliance of theory with practice to increase the profits of the butter-maker. Much superfluous teaching is indulged in, and dairy instructors should use discretion in imparting theoretical knowledge.

Curing Butter.—The making of local butter for storage is an art prized by country butter-makers at home and abroad. We are told there are secrets associated with the practice, and these are often carefully guarded. The real secrets make a very attractive trio, namely, "common sense, cleanliness, and sound practice." This is the sum total of the writer's inquiries into the system of butter-curing followed in different countries of the world.

In an oversea dominion a famous curer's secret formula was as follows:—

1. Feed and treat the cows to produce good flavoured and long keeping milk.
2. Milk them to do likewise.
3. Set the milk in fresh, pure air, and where there is daylight.
4. Ripen the cream in the same healthy atmosphere, exposing as much of it as possible.
5. Have one ripeness and one flavour.
6. Churn at a cold temperature in a cold place.
7. Brine the clean grains in a weak salt and a weak borax mixture.
8. Pack in a glazed crock.
9. Cover with a salt and borax solution, and put an air-tight cap on the crock.
10. Keep in a cold place by itself, and pure air.

There is something modern about these rules. In those days the setting system was in vogue. It certainly had very great advantages in capable hands. This is due to the cream ripening in a thin layer, and in immediate contact with sound, wholesome milk, in which predominates a pure natural ferment. It cannot be too often repeated that to get perfect ripening and a perfect flavour there must be plenty of fresh air, and enough pure food for the organisms.

In the manufacture of butter for curing it is very essential that the milk should be of a high standard of purity and absolutely clean. Readers now fully understand that bacteriological contamination is fatal to the flavour and keeping properties of the butter. In the first instance, the cream should be aerated, then ripened as directed in this book. Churning at a lower temperature than usual is desired, and partly salting with a brine and borax solution is recommended, in preference to adding all the preservatives in a dry state. Working requires very great care. When a borax preservative is used in conjunction with salt, it must not exceed 1 oz. to 14 lb. of butter (British law allows 0.5 per cent. borax in butter). In brining, use three-quarters of the borax, and on the worker make up to half the original quantity. After rolling the freshly removed butter a couple of times, half of the salt and borax mixture should be sifted evenly over the thin layer of butter. In 1 to 1½ hours the butter is again rolled out, and the remainder of the salt and borax is added and worked into the butter. It is now put to one side in a cool place. After an interval of about six hours the working is completed. A crock is got ready, and after scalding and cooling, the butter is added in small quantities, packing taking place from the centre only. When full, a piece of wet parchment is put over the butter, then wet muslin, and finally a layer of dry salt and borax half an inch deep completes the work.

Terms Used in Describing Butter

As all important dairying countries export butter to the British market, a lasting good would be done if some uniformity could be arrived at in describing the various qualities of the produce. The leading defects known to dairy authorities are to be found in the butters of all countries, and there should be no difficulty in drawing up a nomenclature that would fulfil valuable and international requirements. Perhaps this question may be considered at some future International Dairy Congress, and if it should ever reach maturity the commercial and educational interests of the dairying industry throughout the world would be materially benefited. The following are terms used in Canada and New Zealand to describe butter :—

CANADA

Flavour

High-flavoured: Pronounced superior flavour, especially to sense of smell.

Sweet : Desirable characteristics applied to high-class butter.

Sound : Denoting good keeping quality.

Fishy : Resembling fish oil.

Weedy : Flavour given by turnips, excessive clover feeding, etc.

Stale : Rancidity due to butyric fermentation.

Musty : Caused by mouldiness.

Strong : Causing a smarting sensation or irritation of the tongue.

Body or Grain (Texture)

Waxy : Butter having a solid consistency.

Spongy : Containing too much moisture.

Milky : Showing milky moisture.

Coarse : Showing lumpy or uneven grain.

Colour

Pale : Meaning very light-coloured.

Mottled : Colour unevenly distributed.

High-coloured : Being higher in colour.

Salting

Saltless or Fresh : No salt used.

Gritty : Denoting the presence of undissolved salt.

NEW ZEALAND

Parcels or Lines

Choice, good, fair, irregular.

Flavour

Choice, good, fair, irregular.

Mild, nutty, clean, full.

Irregular, poor, should be cleaner, should be more regular.

Inclined strong, turnipy, rancid, tallowy, strong and unclean.

Sweet or sour.

Body and Texture

Close, firm, solid, waxy.

Open, soft, weak, greasy, salvy, lumpy.

Showing free moisture, cloudy atmosphere, or milk moisture.

Colour

Mottled, streaky, shaded.

True, straight, uniform.

Finish

Boxes neat, clean, and attractive.

Branding smudgy ; brand not sufficiently impressed. Boxes split, boxes soiled.

Inferior parchment used ; boxes badly lined.

Flavour

A good flavour in butter is defined as something that pleases the taste, something that leaves a pure and delicate aroma of cream in the mouth. There is nothing that one can object to—no bitterness, no acidity, no stale or aged taste ; it is alone the flavour of a choice product, that has been manufactured from choice cream, separated from pure and carefully-handled milk.

Insipid.—Occasionally one finds a consignment of butter practically without flavour of any kind. Examination of the texture may show that care has not been given to the working. Flavourless butter may be attributed to churning under-ripened cream. Succulent and immature foods exert an influence, but not sufficient to seriously impair the aroma when proper precautions are adopted in the ripening and churning of the cream.

The chief cause is over-washing the butter, which takes away the delicate flavour, and the practice of washing on the worker is without doubt carried to excess in some factories. Extreme care is necessary in conducting this operation, and it should not be done except when washing in the churn has not been sufficient to free the grains from the buttermilk.

Butter made in some districts has what might be termed a constitutional weakness. In such cases the special attention of the butter-maker is required to prevent a further weakening of the aroma, and a starter should be used in the cream whenever practicable.

Weedy.—Plant flavours in some countries give rise to very serious trouble. The eradication of the injurious plants has been recommended, and no doubt when a better system of dairy farming is practised this will be done. Aerating milk and cream immediately after milking and separating and pasteurising will go a long way to remove these objectionable taints.

Acid.—Occasionally an acid flavour is found in butter, which gives the impression that a large percentage of buttermilk is contained in the product. This is frequently the cause, but the writer has found supplies free from a cloudy brine, while the acid flavour was quite pronounced.

To prevent acidity, dairy farmers are again advised not to supply cream of a watery consistency to the factories.

In cans of thin cream a deep layer of coagulated milk is invariably found at the bottom, and when this very acid body is mixed with other supplies serious injury results. (Note mottled butter.) Observations lead the writer to believe that this fault is a responsible factor for acidity in butter.

Rancid.—Rancidity in butter is a defect the dairying industry must strenuously guard against. It shows grave errors in the collection of the cream and its general treatment. The smell—not aroma, as some writers speak of—and flavour of rancid butter stamp the commodity as unfit for classification as a table product.

Rancidity will develop quickly in badly washed butter.

Experiments conducted by the writer proved that the germ of rancidity will grow in butter that is heavily preserved with boric acid. The vitality of the germ also enables it to survive low temperatures, and to reproduce itself when conditions become favourable.

Tallowy.—This is a defect butter-makers should study very carefully. The trouble is common in the summer months, but it is not unusual to find instances in the colder seasons of the year.

The flavour of the affected butter is readily recognised, and the condition of the texture invariably confirms the examination. Heated cream, when over-ripe, and if rapidly cooled, will encourage a tallowy flavour.

Churning at a high temperature and overworking have a similar injurious effect.

Working butter when it is too hard is also a hurtful practice. The action of the rollers greases the product, making it subject to a tallowy flavour.

The exposure of boxes of butter to atmospheric heat, and if subsequently chilled, the texture of the butter will suffer so much that tallowiness will in many cases be found a few days after the produce is thawed. With weak-bodied butter the change will be more marked. In Denmark rusty cans are put down as a cause. Tallowiness is one of the few flavours that defeats the blender and the manufacturer of renovated or process butter.

Cheesy.—A cheesy flavour is usually found in butter that has been kept for some time, but keeping does not cause the injury—it merely aids in its development.

The flavour may be detected in freshly made supplies. The cause is attributed to old cream, carelessness in sterilising the vessels, also want of attention to other matters of cleanliness.

Cowy.—A cowy flavour is caused by the use of "Colostrum" milk, also by bad ventilation of cowsheds, and ill-health of cows.

"Colostrum" is fully described in Chapter III., pp. 133-35.

Stale.—Stale butter freshly made shows that the cream has been kept too long, or that it was ripened under very unfavourable conditions. It is the worst taint in cream we have to deal with, and at once condemns the keeping properties and monetary value of the butter made from it.

Inferior cream cans and want of cleanliness are productive of a stale quality in cream. As shown in a previous chapter, full inquiries were made into the question of inferior cans causing taints in butter, and the evidence illustrates the very serious danger of using these vessels.

Mouldy, Musty, and Woody Flavours.—The storage of milk and cream in rooms containing general lumber, and where the air is dust-laden and light excluded, exposes the produce to a foul atmosphere, which it absorbs. The bacteriological plates on pp. 307-10 illustrate how contamination can be brought about by this cause.

Mouldy and musty flavours will develop in butter, through the use of salt which has been stored in badly kept rooms, or where there is insufficient protection to prevent impurities in the air from becoming absorbed by the salt. Inferior butter boxes and paper are also productive of the same faults in flavour.

Texture

Causes of Variation in the Percentage of Water.—The British standard for water in butter was fixed at a maximum of 16 per cent. by a Royal Commission, and the Commonwealth Parliament have recently approved of the same standard for Australia. This will necessitate very great care on the part of Australian factories to keep the water percentage of their exports to Britain within the law, and on this account the subject under consideration should prove the more interesting.

In the extensive dairying countries of New Zealand and Australia, the fine body and the dry texture of the butter are qualities that stand out very prominently, and it will be accepted by practical and scientific men alike, that the keeping properties of the product are extended by virtue of these great factors. (See Blending.)

Is the Steel Trier a Practical Test for Moisture?—The use of the steel trier is misleading as a guide of the water content of butter. The following tests by the writer will show the fallibility of the grading iron :—

No. of Sample.	Percentage of Water Found.	Indications of Moisture on Trier.	Consistency and Texture.
1	9.0	Very dry	Greasy, overworked.
2	12.5	Very moist	...
3	10.9	Very moist	...
4	14.1	Very dry	...
5	10.1	Moist	Greasy, overworked.
6	11.0	Moist	...
7	11.8	Dry	...
8	11.5	Very moist	...
9	11.5	Moist	...
10	11.4	Dry	...
11	11.5	Dry	...
12	10.5	Very moist	Greasy, overworked.
13	11.2	Dry	...
14	11.3	Dry	...
15	10.1	Dry	Greasy, overworked.
16	10.2	Dry	Greasy, overworked.
17	12.2	Very moist	...
18	13.2	Dry	...
19	11.4	Very moist	...
20	12.3	Fairly dry	...
21	13.3	Moist	...
22	10.4	Dry	Greasy, overworked.
23	10.0	Moist	...
24	15.0	Dry	...
25	14.8	Dry	...

No. 4 shows a high percentage of water, with a very dry appearance by the trier; but the butter was unsalted. This peculiarity will be considered in another page.

Experiments to Determine the Causes of Variations in the Percentages of Moisture

Conducted for the South Australian Government by the Writer in 1899

For this purpose twenty-one boxes of butter were prepared; and throughout the process of manufacture, from the separation of the cream until the finished article was packed, great care and attention were given to obtain correct results. In taking the samples of butter for analysis every precaution was adopted, and the percentage of water in each case represents an average of three determinations.

In the first test, six boxes of butter were manufactured, the chief object being to ascertain the effects of temperature and salting on the degree of moisture.

The experiments were conducted in the winter months.

The following table gives particulars of manufacture :—

TEST I

	Box 1.	Box 2.	Box 3.	Box 4.	Box 5.	Box 6.
Temperature of cream when churned	54° F.	58° F.	56° F.	56° F.	56° F.	56° F.
Acidity of cream	0.58	0.58	0.59	0.59	0.59	0.59
Minutes in churning	24	20	22	23	23	23
First washing, 5 gals. water	...	..	...	...	...	. .
Second washing, 5 gals. brine	...	...	...	...	...	...
Pounds of salt to 5 gals. water	1	1	...	...	3	5½
Pounds of salt to 100 lb. butter	2½	2½	5	2½	nil	nil
First working minutes	1¾	1¾	1¾	1¾	1¾	1¾
Second working minutes	1¾	1¾	1¾	1¾	1¾	1¾
Time between working hours	40	40	40	40	40	40

WATER ANALYSES OF THE BUTTER

No. 1	11.1 per cent.	Difference due to temperature of cream churned.
,, 2	12.5 ,,	
,, 3	10.5 ,,	
,, 4	12.7 ,,	
,, 5	13.4 ,,	Difference due to salting.
,, 6	14.6 ,,	

In working the samples, the speed of the roller was 45 revolutions per minute, and the salt, where used, was added immediately after the first making. The temperature of the fresh water for washing the butter grains was the same for each churning.

Temperature. — In each box of butter, excepting Nos. 1 and 2, the temperature of churning was 56° F. Observe the difference in water percentage of sample No. 2, which was churned four degrees higher than No. 1, other conditions being exactly the same from first to last. It is to be expected when cream is churned at a high temperature that the oily consistency of the butter will afford a good resting-place for particles of water, and the moisture will be so well divided that working will be more injurious than beneficial. As previously shown, the equipment of factories with the best refrigerating machinery will minimise the losses that otherwise would be sustained, but cream which has been overheated will produce a butter of delicate texture and subject to tallowiness even when cooled before churning, and the butter grains washed in chilled water.

Salting.—It is an established fact that the amount of salt added to butter influences the water content of the product. But there is a good deal to be determined as to the extent of the variations. For example, sweet butter will generally have more moisture than a medium salted article, whilst the heavily salted product will give the highest proportion.

In turning to the analysis of No. 3 box in Test I., it will be seen that the proportion of water was less than in No. 4. This can be attributed to the double quantity of salt taking up the moisture better, and had more than 5 lb. been added, a higher percentage than 12.7 would have been retained in the butter. To prove this contention, a quantity of cream was churned, and the butter divided into three lots. One was salted at the rate of 5 per cent., another 7 per cent., and the third 10 per cent. Each received only one working, and upon analysis 5 lb. of salt left 15.4 per cent., 7 lb. 17.9 per cent., and 10 lb. 18.8 per cent. of water in the butter.

On account of the difference between the unsalted and salted butter, six boxes were manufactured from equal quantities of the same consignment of cream. To half of these $3\frac{1}{2}$ per cent. of salt was added, while the other three were worked without the addition of any salt.

The following is the result:—

	Unsalted Butter.	Salted Butter.
	Per cent. of Water.	Per cent. of Water.
No. 1	13.2	11.8
" 2	14.2	11.4
" 3	14.1	12.3

The above figures show that in the unsalted butter there was a marked increase in moisture, but this was not detected by the trier—on the contrary, for the opposite indications were given.

The table of water analyses and trier tests gives an illustration of the above. One sample of butter (No. 4) contained 14.1 per cent. of water, and, judging by the trier, the butter was very dry. It would appear that butter in the absence of salt does not yield its moisture to the good influence of the worker; but in the presence of an average percentage of salt, the water gathers in drops throughout the body of the butter, and escapes from the worker with a proportion of the dissolved salt. By reason of the salt gathering the water, and the possibilities of it becoming locked up in unevenly distributed proportions, the excess of moisture shown by the trier in "dry" butter may be accounted for. Again, when excess of salt is added, the water percentage is increased, and before working is concluded the separation of the excess of moisture from the butter will be impossible.

With regard to the influence of brine on the moisture content of butter, it will be noticed that an increase of $2\frac{1}{2}$ lb. of salt in the brine of No. 6 box gave 3 per cent.

more water, and an increase of 5 per cent. over No. 1, in which $2\frac{1}{2}$ lb. of dry salt were added and 1 lb. dissolved in the water. No. 5 box, with 3 per cent. of salt to the 5 gals. of water, gives 1.8 per cent. more water than No. 1, and 2.9 per cent. in excess of No. 3 box, which was salted at the rate of 5 per cent.

In this particular case, where 5 per cent. of dry salt was the maximum quantity used, and $5\frac{1}{2}$ lb. the maximum added to the brine, there is convincing evidence to prove that brined water will increase the percentage of water more than when dry salt is added on the worker.

TEST II

The Butter-Worker.—The treatment of butter on the worker is so important a matter that a saving of money can be made by careful and skilful management. In manipulating the appliance properly, the operator should study the solidity and texture of the butter as soon as the granules are formed in the churn; but this is not sufficient to satisfy intelligent and enterprising managers. The temperature of the room must be considered, and the probable moisture that the butter contains. Both judgment and skill are required, so that a sufficient percentage of water is left in the butter without damaging the fat and keeping properties of the product.

It will be observed in the tests that in a large number of samples a low degree of moisture accompanied a greasiness of texture. This defect is very pronounced in consignments of milled butter that are prepared in ordinary butter factories, and it is reasonable to attribute the dryness of the product to the addition of extra quantities of dry salt and extra working; also, milled butter is often the product of dry, over-ripened cream.

In carrying out Test II. all conditions in the manufacture of the butter were exactly the same, the only difference being in the working, as given below :—

	Box 7.	Box 8.	Box 9.	Box 10.
First working (in minutes).	2½	2½	Worked once, being the same time as the two workings of box 7, and at the same speed of roller.	Worked once, being the same time as the two workings of box 8, and at the same speed of roller.
Second working (in minutes).	1½	1½		
Revolutions of roller (No. per minute).	45	19		
Hours between working.	17	17		

Percentages of Water.—No. 7, 12.0; No. 8, 11.5; No. 9, 13.5; No. 10, 11.3. The above percentages of water go to show that the slower speed of the rollers favoured a freer escape of moisture. Sample 7, with a roller speed of 45 revolutions per minute, and two workings of 2½ and 1½ minutes respectively, gave 12 per cent. water; and sample 9, with one working (four minutes), and of the same speed, leaves 13.5 per cent. of water in the butter; while the slow working of butters 8 and 10 produces a drier article. The writer has always been opposed to fast working, and would suggest the necessity for closer attention to this factor in butter-making. No. 9 illustrates in a striking manner that water becomes locked up in the body of butter when it is exposed too long to a quick-moving roller, and a second working will not expel the excess of moisture and will inflict serious damage on the texture and other properties of the butter. Further, there is good reason to believe that overworking freshly churned butter distributes the moisture so finely amongst the butter fats that a dry appearance is given to the finished article, while the butter may yield on analysis a high percentage of water. A comparison of results obtained by the steel trier and chemical analysis would seem to support this opinion.

TEST III

Butter Grains and Drainage in Churn.—Test III. was undertaken to ascertain what effect the size of butter grains in the churn, also the influence of drainage in the churns and salting, would have on the dryness of the butter.

Altogether eight lots of butter were made. The first four were treated as follows:—

	Box 11.	Box 12.	Box 13.	Box 14.
Size of grains	Rice.	Peas.	Rice.	Peas.

Boxes 11 and 12: Brine in churn; 1¼ lb. salt to 5 gals. water; dry salt, 3½ per cent. Boxes 13 and 14: No brine; washed twice; dry salt, 3½ per cent.

Equal quantities of water were used for washing the butter. The butter was given thirteen minutes to drain in the four lots, and the time of working was two minutes for the first, and two minutes for the second, while the speed of the roller was the same throughout. Fourteen hours between the workings were allowed. The temperature of the cream and washing water was 50° F.; acidity, 0.58; and the time of churning varied very little. The same percentage of fat (0.1) was found in the buttermilk from each churning.

Percentages of Water.—Box 11, 12.2; Box 12, 12.2; Box 13, 12.5; Box 14, 12.3. According to the above analysis there is practically no difference obtained by churning into grains of small or large size, and the slight difference in salting has not affected the water percentage.

DRAINAGE IN CHURN

	Box 15.	Box 16.	Box 17.	Box 18.
Size of grains	Pin-Heads.	Pin-Heads.	Peas.	Peas.
Time of draining in minutes.	20	20	4	4

All other conditions were exactly the same.

No. 15, 11.8; No. 16, 11.4; No. 17, 14.5; No. 18, 15.4. Nos. 15 and 16 favour a distinctly drier butter than Nos. 17 and 18, and this undoubtedly arises from the longer period given to the drainage of the water from the butter grains. Where four minutes were allowed, the percentages of water increased much above the average.

There is an important factor to be considered here, namely, the solidity and dryness of butter. In this connection the writer will refer to the feeding of milking stock. In exhaustive trials which he conducted in 1901 on the feeding of cows with different rations, it was determined by analyses of the butter that the food given to the cows and the season of the year influenced the fats and water-carrying properties of the butter.

The following are the analyses of ten samples of butter from the cream of test cows that were stall-fed on certain rations. In the manufacture of the butter no departure was made from the ordinary practice.

	Water per Cent.	Fat per Cent.		Water per Cent.	Fat per Cent.
No. 1	10.54	86.12	No. 6	7.58	89.68
„ 2	10.37	85.69	„ 7	7.26	89.11
„ 3	6.68	90.59	„ 8	8.36	87.68
„ 4	7.07	90.49	„ 9	9.40	88.07
„ 5	7.13	89.27	„ 10	9.05	88.07

Moisture Standards of Butter.—Owing to the differences of the standards of moisture in butter-producing countries, it would be advantageous in many ways if the standard could be brought more into line. No butter has a legal right to be marketed in Britain which contains more than 16 per cent. of moisture. This compels manufacturing countries operating in the British market to adjust their standards. Were one standard adopted it would harmonise the system of butter-making, to the advantage of export countries.

Water Standards of Butter in Different Countries

In connection with inquiries into the above subject, also foreign breeds of cattle, the writer has to thank British Consuls abroad for information obtained.

In Great Britain, Ireland, Australia, New Zealand, and Canada, the water standard of butter is 16 per cent. In some foreign dairying countries it is stipulated by law that all export butter to Britain shall not contain more than 16 per cent., but for consumption within the country special provisions are generally made.

Holland.—Standard, 18 per cent. Butter is permitted to be sold containing different percentages of water, but the product must be wrapped in sealed (*plomlies*) packages, on two sides of which a notice appears in the French and Flemish languages as translated below :—

> *Butter mixed with Water*
>
> NOTICE
>
> This butter contains ... per cent. of water, casein, and lactose; a pure butter containing not more than 18 per cent. water.

Butter in Holland is sold containing as much as 35 per cent. of water, and even 40 per cent. is not uncommon, but only on the condition stated above.

Germany.—The water standard varies, according to whether the butter is salted or unsalted. In the former case it must not exceed 16 per cent., in the latter it averages 13 per cent.

Norway.—It will be observed from the tables to follow that Norwegian butter averages a fairly low percentage of water compared with other countries. This is no doubt chiefly due to the fact that free brine in the butter is not countenanced in the ordinary trade in Norway, and with an unrestricted supply of ice and cold water, churning generally takes place at a comparatively low temperature. By working at low temperatures, the butter is unable to hold a high percentage of moisture, and it escapes as free brine.

As the percentage of water in Norwegian butter is so low as to preclude fear of injury to the trade, it has not been found necessary to pass legislation on the subject.

Argentine.—16 per cent. is the standard fixed by the Government.

Russia.—Butter intended for export is not expected to contain more than 16 per cent. water. Guarantees are given by the Government, as shown in the following example taken from a Russian Dairy Bulletin :—

> We guarantee to A. CLEMENTS & SONS, LTD., that this butter is pure, and does not contain over 16 per cent. of water.
>
> *Signed*................................

A highly skilled staff of chemists are kept by the Russian Government in connection with the Siberian butter trade, and their reports show that close attention is given to the water content of export butter, and to other features of importance.

Netherlands.—The Dutch law prescribes that the minimum of butter fat must be 80 per cent., and all butter that bears the control mark of the State must not contain more than 16 per cent. water.

Switzerland.—Standard, 16 per cent. Minimum fat, 82 per cent.

Italy.—Standard, 16 per cent.

Austria.—At present there is no legal water standard, but this will be fixed at 18 per cent. in the new Austrian Codex Alimentums, which will shortly be issued.

Denmark.—By section 1 of the Danish Dairy Laws of 1911 it is forbidden to export from Denmark butter that contains more than 16 per cent. water.

By section 2 of the same Act, butter containing more than 16 per cent. and not more than 20 per cent. of water can be sold in Denmark, but must be marked "*vandsmir*" (water butter), according to regulation. Butter containing more than 20 per cent. of water is confiscated.

Sweden.—According to the Royal Swedish Ordinance of 28th May 1911, when butter is exported, the casks in which it is contained have to be provided with a brand indicating whether or not the butter contains over 16 per cent. of water. This standard is verified by official experts.

Belgium.—Butter may not contain more than 18 per cent. of substances other than butter fat and salt, unless enclosed in receptacles bearing a statement that the butter is mixed with water, and the proportion of water, etc., that it contains.

Testing for Moisture.—Within recent years a number of appliances have been put on the market for the above purpose. Some have not attained their object, owing to difficulty of manipulation, or the fault of the apparatus to give a correct estimate of the water content. That a simple test is invaluable all agree, and for general purposes the class of apparatus seen in the illustration will meet the wants of factory managers and others desiring to regulate the water percentage of butter, and to avoid complications with the law. The manipulation of the test offers no difficulty. A representative sample of the butter to be tested is carefully weighed in the aluminium dish seen on the balance. It is then heated on the bunsen until all moisture is driven off.

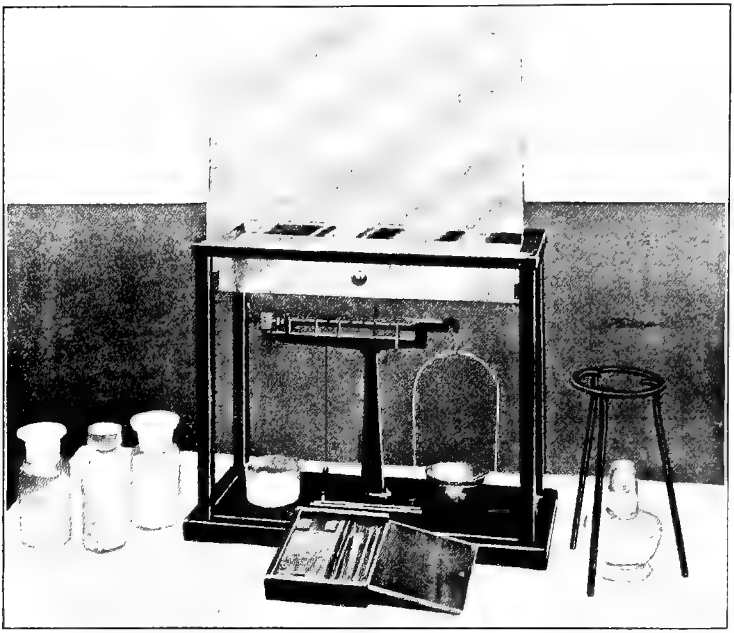


FIG. 12.—Simple Apparatus for ascertaining the Water Content of Butter (Heyman).

After sufficient cooling the dish is again weighed, and the difference represents the loss of water.

The water content of the butter imported from different countries varies, as shown by the following percentages supplied by the Board of Agriculture :—

Country from which Imported.	Number of Samples.	Average per Cent. of Water.
Belgium	9	15.05
United States	41	14.63
Holland	134	14.16
France	117	14.13
Argentine	36	13.51
New Zealand	131	13.49
Sweden	75	13.08
Australia	119	13.08
Iceland	4	12.30
Russia and Siberia	149	12.30
Denmark	412	12.23
Norway	29	12.21
Canada	37	11.92
Germany	16	11.07

The Danish butters include a considerable number of samples of Russian, Siberian, and Swedish butter that had been reshipped from Danish ports.

Consignments of butter from Ireland are not sampled by Customs officers. The Irish authorities have their own staff of inspectors in Britain for this purpose.

The average percentage of water in the samples of butter taken from consignments from the separate States of the Australian Commonwealth during the above period is shown below :—

State.	Number of Samples.	Average per Cent. of Water.
New South Wales	25	11.74
Victoria	86	13.40
Queensland	8	13.57
South Australia	...	...
	119	13.08

The range of the percentage of water in the Australian samples is given in the following statement : —

No. of samples containing		16	and under	17	per cent.	1
,,	,,	15	,,	16	,,	9
,,	,,	14	,,	15	,,	28
,,	,,	13	,,	14	,,	28
,,	,,	12	,,	13	,,	27
,,	,,	11	,,	12	,,	15
,,	,,	10	,,	11	,,	5
,,	,,	9	,,	10	,,	4
,,	,,	8	,,	9	,,	2
					Total,	119

How Moisture Varies in Individual Boxes or Kegs of Butter. —In this chapter the writer has shown how the water content may be influenced by the process of making. This is further reflected in the analyses of Colonial and foreign butter upon arrival in British markets, as given below : —

	Boring from Centre.	Boring 4 in. from Centre.	Boring 3 in. from Edge.
Box 1	12.2	12.4	12.0
	12.4	12.1	12.5
	12.3	12.5	12.6
Box 2	14.8	15.3	15.1
	15.2	15.0	14.9
	15.0	14.8	14.7
Box 3	15.8	15.9	16.3
	16.1	15.7	16.0
	16.3	16.1	15.8

An even distribution of moisture in export butter will raise its keeping properties, while on the other hand a patchy or uneven moisture content will assist in the deterioration of the butter, particularly if the quality is not high to begin with, and if the butter contains an excess of curd.

The writer considers that the water content of butter is regulated by the following conditions :—

1. Feed and season of the year.
2. Temperature of cream.
3. Age and ripeness of cream.
4. Drainage of butter grains in churn.
5. Temperature of churning-room.
6. Temperature of washing water.
7. Strength of brine used.
8. Quantity of dry salt added to butter.
9. Speed of rollers, and time of working.
10. Kind of rollers and worker used.
11. Quality of salt.

Milky or Cloudy Butter.—When butter shows a milky appearance, it illustrates that an error has occurred in the process of manufacture. Mistakes in production, however, are not always to be attributed to the butter-maker, as it frequently happens that the condition of the cream, and the temperature of both cream and washing water, causes a high percentage of buttermilk to be retained in the finished product. In churning over-ripened cream, before the temperature of the fat has been sufficiently reduced, difficulty is met with in getting rid of the buttermilk, and this danger is increased when over-heated cream has to be treated. To obtain a thoroughly cooled condition in the cream, the whole body should come under the influence of the cold in the ripening vats, and with a gradual lowering of the temperature the different constituents of the cream will be equally affected. It has previously been stated that a churning temperature of about 48° F. in summer is recommended for factories.

The action of buttermilk on the flavour and keeping properties of butter is very marked. Fermentation takes place rapidly when the butter is not refrigerated, the good flavour disappears, and a rancidity develops to the ruin of the product.

Another, and probably the commonest, cause of milkiness in butter is insufficient washing. Before removing the butter from the churn to the worker, the last washing water should show practically no discoloration when drained off.

Churning under-ripe cream increases the difficulty of washing the butter, as the want of acid leaves a stickiness in the cream, or, in other words, the globules of fat and the milky or caseous matter are more difficult to separate.

It should be to the interest of factories to make regular tests of the proportion of curd, and when found high, the cause should be immediately looked for and corrected.

The following are percentages of curd in butter given in a report of the Board of Agriculture, and arranged in order of proportion.

Country of Origin.	No. of Butters.	Range of Curd.		Average percentage of Curd.
		Lowest.	Highest.	
Germany	5	1.03	1.39	1.18
Belgium	6	1.04	1.38	1.15
Denmark	20	0.78	1.51	1.14
France	41	0.44	1.86	1.11
Holland	62	0.74	1.53	1.11
Sweden	21	0.81	1.46	1.11
Undenlandsk butter from Denmark	41	0.61	1.48	1.10
Russia and Siberia	102	0.43	1.64	1.08
Australia	32	0.54	1.34	0.82
New Zealand	27	0.48	1.36	0.77
Argentine	8	0.40	0.94	0.64

Coarse.—A coarse body in butter is sufficient proof that the churning has been allowed to proceed too far, causing the butter fat to form irregular lumps, instead of grains of equal size. When dealing with lumpy butter, as well as when the grains are fine, care in working should on no account be overlooked.

Greasy.—A greasy texture is met with in all countries, and especially in the summer weather. Over-ripe and heated cream seriously affects the texture of butter, and particular attention is required in the churning and working. Overworking the first time cannot be remedied, and cooling the butter too much in the chamber before the second working is a source of injury.

Dry and Hard.—During the cold season of the year hardness of butter is often a complaint, and a number of practical investigations to determine the cause have been conducted by the writer.

In certain districts it is found by experience to churn cream at an exceptionally low temperature, owing to the peculiar physical properties of the product.

A low percentage of water usually accompanies a hard textured butter. In the analyses of six samples, four of which were hard and two soft, the following proportions were found :—

Hard butter—6.153, 7.323, 7.834, 7.981.
Soft butter—10.761, 10.832.

The density of the samples was taken, and a complete fat analysis made. The hard butters were shown to have a higher melting point and a higher percentage of hard fats than the soft samples.

One of the characteristics of blended butter is its soft texture. This is brought about by the severe crushing and mixing the butter is subjected to, and the high percentage of water which it contains is in a finely divided state and does not show on the iron.

Observations made in different countries, and which have already been given, prove that the solidity of butter is influenced by climate, soils, and that the "ripeness" and variety of herbage, also the period of lactation of cows, play an important part. Maize, bean and pea meals, and all dry fodders harden the texture of butter.

Suggestions to Prevent Hardness

1. Wherever practicable give succulent food to cows. Meals should be moistened some hours before feeding.
2. Give the cows plenty of drinking water.
3. Separate the milk morning and evening. If the quantities are too small to necessitate separation twice daily, heat up the cold milk to over 100° F., and separate by itself. Run warm water through the separator before working.
4. If churning is done twice a week ripen the cream in one can and keep in warm place. Use a starter. Do not add fresh cream to bulk later than twelve hours before churning.
5. Churn cream at a higher temperature than usual. If cream is too low in temperature, add warm water to bring it up to the most suitable degree as found by experience.
6. Pour a quantity of boiling water into the churn ten minutes before churning, and rinse out immediately before cream is added.
7. Churn into grains.
8. Wash once with water that has the cold chill taken off.
9. Add a quantity of brine as a second washing.
10. Work a few seconds and add best quality of salt and not more than $1\frac{1}{2}$ per cent.
11. Work carefully and thoroughly.
12. Do not work a second time.
13. Do not keep the butter in the coldest place in the house.

The following is a summary of the principal causes :—

1. Quality of food, system of feeding, and lactation period of cows.
2. Practice of separating cold milk.
3. Ripening cream in small quantities in cold rooms.
4. Churning at low temperatures.
5. Temperature of washing water too low.
6. Overwashing.
7. Use of inferior salt.
8. Excess of salt.
9. Overworking.

Oily Texture.—Fat retains heat longer than the other solids of milk ; cream is therefore more difficult to cool owing to the high percentage of fat which it contains. For example, if cream after quick cooling registers 60° F., the fat content would show a higher temperature, consequently the consistency will be weak. Churning the cream before it is properly cooled will, therefore, cause an oily texture in butter, and a loss of fat in churning. A similar fault in butter is attributed to heated cream.

Colour—Mottled and Irregular.—A mottled condition is readily distinguished from streakiness by the absence of the marbled appearance of the butter which is the chief feature of the defect. Butter affected with mottle may show either white particles of curd or a bleached-like appearance of the fat showing as specks.

When in South Australia the writer had occasion to investigate the cause of mottle in a well-known brand of export produce. The factory complained of was visited and the butter-maker was found at work charging the churn with cream. As the cans were being emptied, quantities of coagulated milk at the bottom were observed to mix with the cream. After churning, numerous specks, varying in size from a grain of gunpowder to boiled rice, were found amongst the butter grains, and in the finished product the cause was confirmed. The fault was due to the thin cream and the want of stirring during ripening, which would have prevented the milk from collecting and coagulating at the bottom of the cans. Straining of cream should be strictly enforced at all factories. The addition of colouring matter to cream that has been carted long journeys and not strained will result in an uneven distribution of the annatto, or, in other words, the lumpy and partially churned cream will not take up the colouring. Cream of a watery consistency will give rise to more trouble than a product containing a higher percentage of fat. There are other causes of mottle which have not been mentioned, but they are of secondary importance.

Irregular.—It is not unusual to find different shades of colour in butter, which may arise from want of care in working, or that a large surface of butter has been exposed too long to the air before packing, also supplies of cream which vary in consistency and density will produce an irregular colour.

Want of uniformity in the colour may be caused by mixing churnings on the worker, or blending them in the butter box. Unevenness in salting will also have a hurtful effect.

Streaky.—Streakiness, though one of the most prevalent and easily detected defects in butter, is also one of the most easily prevented. Its presence in a well-appointed factory is inexcusable, and in nine cases out of ten is the result of carelessness or incompetency on the part of the maker. One has only to compare butter of even colour with a streaky sample to recognise the objectionable appearance of the latter.

Streakiness is chiefly attributed to insufficient working. Butter worked once only, frequently suffers from this defect, and where coarse salt is used the danger is increased, for the following reason : sufficient time has not elapsed to allow the large grains of salt to dissolve and to become incorporated in the butter, thus deepening

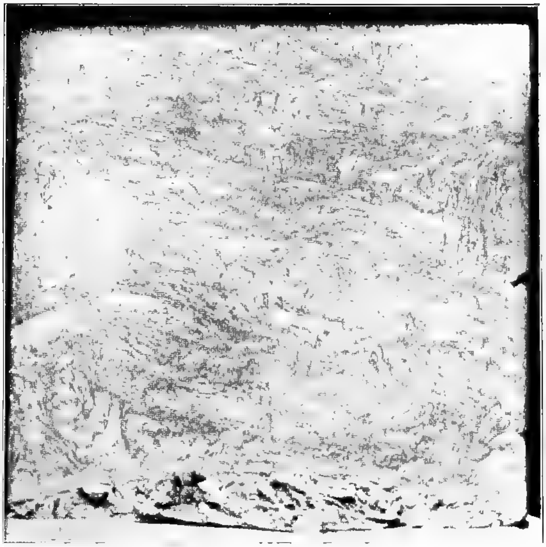


Photo by] [*Mobsby, Brisbane.*

FIG. 13. A Remarkably Fine Photograph showing Streakiness in a 56-lb. Block of Butter (Thomson).

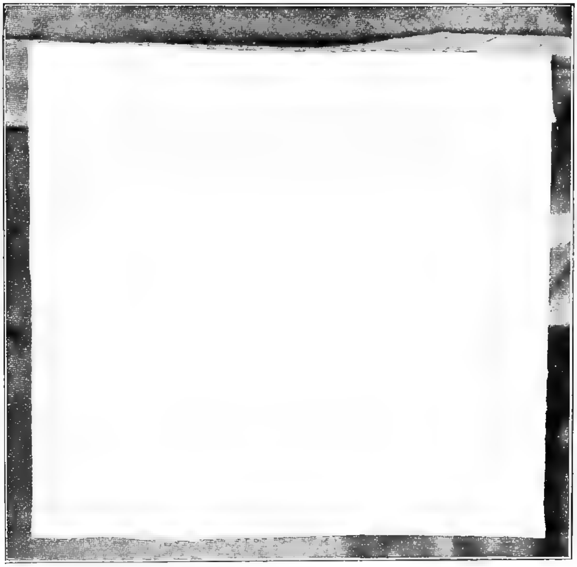


FIG. 14.—56-lb. Block showing Natural Appearance.

the colour of some portions while giving a lighter shade to other parts. A section of butter as above described could be compared to a geological formation in the earth, the streaky patches in the former corresponding with the alternate layers of strata in the latter. Working of the butter should be done as described in this chapter, and only the best brands of salt should be used in choice grades.

Salting—Gritty.—When salt has not dissolved properly, a gritty condition is felt in the mouth. To remedy this, attention should be given to the quality of the salt, and precautions taken to thoroughly incorporate it with the butter on the worker.

Salt Granules and Incrustations.—Particularly in warm countries, pounded butter may be seen with the paper wrapper encrusted with salt or covered with particles like fine flakes of snow. The butter itself may exhibit this latter condition. The cause is attributed to inferior salt, and the water being over-saturated with the preservative; also when cows are advanced in lactation, and the season dry, the defect is likely to be more troublesome.

Packing and Finish.—In packing butter, the first thing to do is to make certain that the inside of the box is thoroughly clean in every part. Cleansing should be done with boiling water or steam, and the box then cooled with a strong solution of brine. By this treatment the timber nearest the butter is sweetened, and moulds and other causes of deterioration removed. After papering, the butter should be added in fair sized lumps and packed with a heavy wooden rammer, care being taken to drive the butter well into the corners. This cannot be done with very large lumps, and particularly if the butter is hard or too soft when put into the box. Neglect of this kind causes cavities in the body of the butter, and in Australia boxes are required to hold 56½ lb. net. It therefore follows that the greater the size and number of

Fig. 15. Defective Packing of Butter (Thomson).

these cavities, the possibilities of short weight will be increased.

In finishing off boxes avoid plastering the surface of

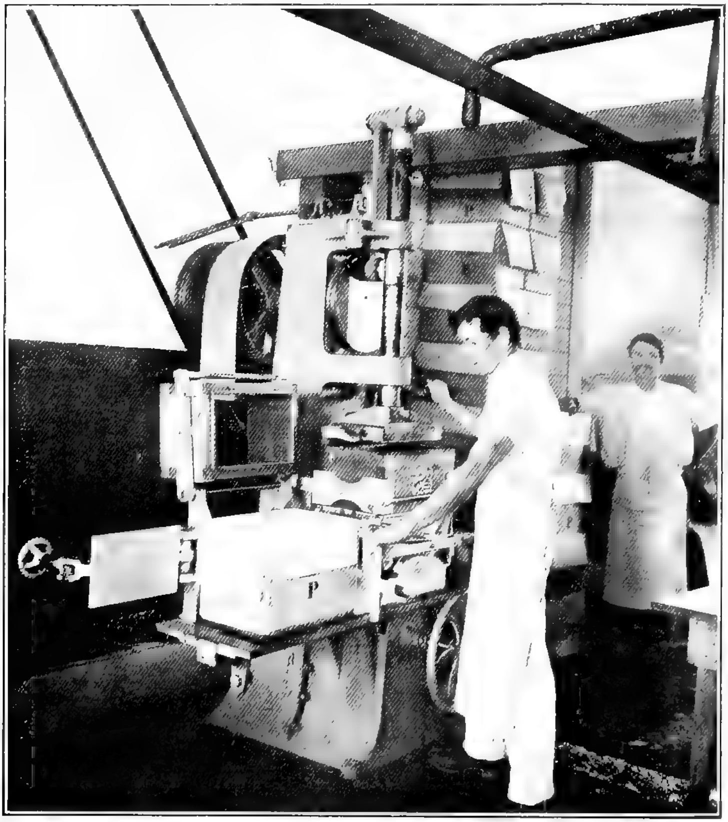


Fig. 10. Power Butter Packer at work in a New Zealand Factory (Dept. Agric., Wellington)

the butter, as this gives it a tallowy appearance. A good roller of neat design that will make fairly deep indentations should be used. In the event of the butter being soft and inclined to adhere to the paper before the latter is folded down, the butter should be kept in the chilling room long enough to harden the surface. When treated in this manner, the paper on being removed will not disfigure the print, and will leave the design intact, showing a waxy appearance of the butter so attractive to buyers. The boxes should be absolutely new, with the factory's brand well stamped into the wood. Ink or any other material for this purpose should be absolutely discarded. An important item in connection with butter boxes is, that timber used in their construction should be thoroughly seasoned, neatly planed, and free from cracks and knots.

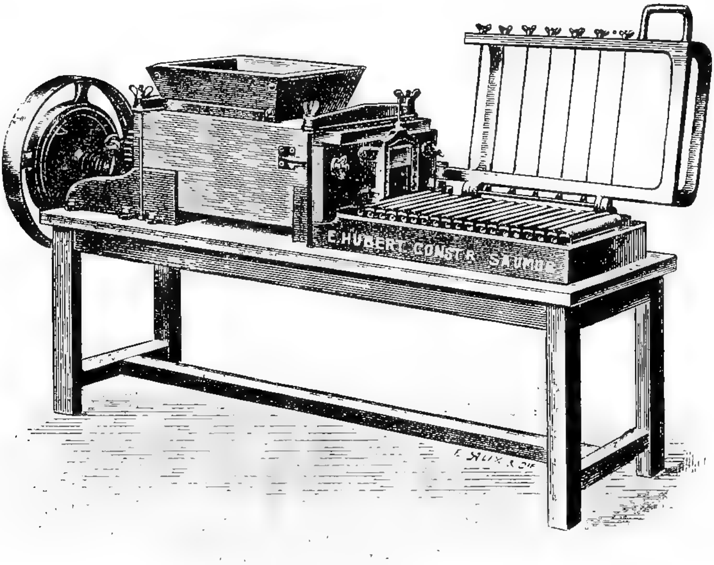

E. HUBERT CONSTR.

FIG. 17. Butter Pounder and Cutter.

Commercial Terms Applied to Butter.—Sweet, choicest, fresh, superfine, salted, powdered, gilt-edged, milk-blended, cured, milled, blended, renovated or process butter.

Sweet butter is the name given to a product in which no salt has been added. In different parts of Britain there is a great demand for this butter. Only the choicest cream can be used in its manufacture.

Powdered is the term applied to a mild-salted dairy butter.

Gilt-Edged. —This attractive title is somewhat abused. It denotes a very high quality, and is equivalent to choicest or superfine.

Milk-Blended.—When inferior butter is treated in the churn with fresh sweet milk, it improves in flavour, retaining a proportion of the milk ; in other words it is a blend of both. The butter is made for immediate sale, and the British law allows it to be sold containing 25 per cent. of water.

Cured. —See p. 99.

Milled.—This implies the re-working of faulty or tainted butters that cannot be sold on their merits.

Blended Butter.—See p. 150.

IMPORTANT CAUSE OF INJURY TO BUTTER

The Water Supply.—There is good cause to believe that impurities in the water supplies of farms and factories are responsible for injurious flavours in butter and cheese. We acknowledge that impure water for milking stock has a harmful influence on the flavour and keeping properties of milk. This is not brought about by the action of germ life in the body of the cow, but by the product of bacteria in the water at the time of drinking. In the making of butter, large quantities of water are used for washing the grains, and, when this practice is properly carried out, every particle of butter is brought into contact with the water. Assuming the supply to be of low purity, what happens? Objectionable organisms and flavours are distributed throughout the butter to the irreparable injury of the product. From the writer's examinations of supplies of water used for butter-making, there is good cause to give prominence to this subject. In one experiment over thirty samples of water were kept in corked bottles, and at the close of from five to fifteen days, when the corks were drawn, strong odours were emitted. All samples were free from smell at the time of collecting; a chemical and bacteriological examination showed the extent of the impurities. This points to what is likely to take place in butter that has been washed with impure water. There are other sources of danger, which can be more readily overcome without incurring cost. Where boiling water and soda are not used in the washing of milk vessels, impurities are introduced into the milk through a contaminated water supply. In the washing of separators, which must be done after each operation of the machine, cleansing with warm water only, seriously endangers the keeping properties of the cream. Filtering and boiling are the two preventive means at our disposal in the treatment of an inferior water supply, and when the former is used in butter-making, and the latter never omitted under any circumstances in the cleansing of milk and cream vessels, injury to produce will be prevented.

Tests were made by the writer to illustrate the bacterial value of boiled and filtered water compared with samples that were not so treated. The results clearly demonstrated how readily butter may be contaminated by the water supply. In a number of cases moulds were cultivated from the water, also varieties of taint-causing bacteria.

COLOSTRUM

"Colostrum" and "beastings" are the names applied to the milk secreted by the cow immediately before and after parturition. The composition of colostrum usually changes quickly after the birth of the calf; but before the milk is suitable for butter-making from six to fourte days must elapse, and in some cases a longer period h been found necessary. The first milk should be given the calf, as it has a healthy action on the intestines. T colour of colostrum is very objectionable, but that is r its worst feature. The flavour is so pungent that hal gallon of cream from colostrum milk when mixed wi twenty times that quantity of sound cream is sufficient destroy the flavour of the butter produced. For chee making the danger is greater, and in no case should m be sent to a factory until the bad flavour has disappear There is abundant evidence to prove that decomposition cheese is hastened, or it may be entirely attributed colostrum. One has only to consider the analysis "new" milk to realise that it has marked putrefacti properties. (Analyses of products are given on pp. 32 326.) It is well established in medical and veterina circles that the mammary glands act as an excreto organ in the removal of waste material from the syste Certain medicines, such as iodine and turpentine, wh given to cattle, may be detected in the milk, just taints are found when cows feed on certain plants. must, therefore, be expected at the birth of the calf, a until the cow's condition is normal, that the milk w be unfit for household and factory purposes. Also wh cows are ill, mating, or drying off the milk becon abnormal. In the latter case, and particularly if milki is done at irregular periods, it will have a disagreea flavour, and should be given to the pigs. Defects cheese-making have been traced to this cause.

Microscopic Appearance of Colostrum and Norn Milk.—In Fig. 18, *a*, *d*, and *e* are cells which ha lost their membranes; *b* and *f* represent cells with la drops of fat; *c* is a cell with a partially destroyed c membrane; *g* and *h*, cells with nuclei.

In Fig. 19, *a* is a large globule of fat; *b*, sm globule of fat. All that is seen are fat globules.

Colostrum corpuscles are the characteristic bodies seen in new milk. They are said not to disappear until a month after calving.

In Fig. 18 the corpuscles are magnified 300 times, and are four or five times larger than the ordinary milk globules when similarly magnified.

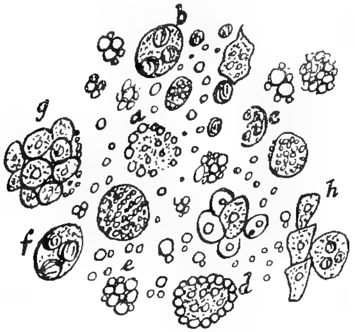


FIG. 18.

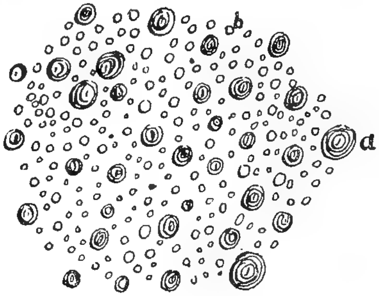


FIG. 19.

Detecting Colostrum.—When colostrum is left to stand it has a tendency to separate into layers. The action of rennet on colostrum is slow. It is curdled by heat, causing the albuminoids to form a thick skin on the surface of the milk. As a warning to milk and cream suppliers of the dangers of colostrum, the writer prepared the following circular, which was distributed throughout Queensland :—

"'THE DAIRY PRODUCE ACT OF 1904.'

"*Notice to Milk and Cream Suppliers.*

"*Dangers of Colostrum and Preservatives.*—The Department of Agriculture and Stock desires to bring under your notice a matter of great importance to the dairying industry. At certain seasons of the year, butter frequently possesses an objectionable flavour, best characterised as 'cowy,' which results from the presence of 'beastings' or 'colostrum' in the milk from which the cream is separated. It is well known that even a small quantity of 'beastings' will injure a whole churning, and that the bad flavour is not destroyed when the butter is put into cold storage.

"As you are doubtless aware, the future of the dairying industry is largely bound up in our export butter trade, and it is therefore essential that we should afford the consumers of our butter no cause for unfavourable comment. The Department desires, therefore, to call your special attention to the fact that, in your own interests and in the interests of other suppliers to the factories in the State, it is imperative that no milk from newly calved cows should be used for butter-making within at least six days after calving, as specified in 'The Dairy Produce Act of 1904,' and in some cases twice that time is necessary before the objectionable odour and taste disappear. This may appear to entail a little direct loss, but suppliers generally will benefit by following the recommendations given here.

"For cheese-making 'new milk' is even more dangerous, as decomposition in the cheese is brought on by its use at an early stage in ripening."

Preservatives.—The use of preservatives in milk and cream is also prohibited under the Queensland Dairy Produce Acts.

The action of powders and liquids sold as harmless or innocuous preservatives is to increase the keeping properties of milk and cream, but when used even in small quantities the cream is injured for butter-making, and the milk for cheese-making is rendered inactive, causing in each instance losses to the industry. This, however, has already been referred to, and a further explanation will be found in the last chapter.

A Fishy Flavour in Butter

Australia's Costly Taint.—Fishiness has reduced the value of Colonial butter by thousands of pounds annually, and for the past ten years the loss will have reached the seven figures. Different theories have been given as to the origin of the flavour. The writer has taken an active part in conducting practical and scientific investigations to locate the cause. The first of these began in 1898, and were continued intermittently for a period of ten years. An abridged account of the investigations should interest the average reader, and particularly the practical butter-maker.

Is Fishiness Associated with Vegetable Life? –The keeping quality and flavour of dairy produce has a relationship to the food of cows and soils. Experience in the manufacture of cheese in different parts of Britain, Australia, and the Near East has convinced the writer that certain defects in produce is the outcome of rank and succulent food of milking cows. It would appear that the plant constituents produce a weak and bodyless quality of milk, poor in hard fats, and this reacts on the flavour and keeping properties of butter and cheese. It is reasonable to believe that the passage of immature and slushy food through the animal's body is too rapid for the digestive juices to perform their functions, hence the blood stream from which the milk constituents are removed, must be charged with substances conducive to changes in the composition of the milk. In Australia and other countries it is recognised that the best-flavoured milk is obtained from cows fed on solid and nutritious herbage, eaten off the land in the dry seasons of the year. The period of digestion of this matured food is slow, hence the more thoroughly will the albuminoids be changed into peptones by the gastric juice, and the action of the intestinal, pancreatic, and biliary juices will be consistent with the quality of the food. Again, with matured food we find ferments at work, their duties being not only to change starch into sugar, but to aid in the digestion of the woody fibre. With immature food this stage of self-digestion will be absent.

That disagreeable flavours in dairy products result from certain foods has been explained, and experience has shown that the danger could be lessened if the taint-producing foods were mixed with matured food to replace the deficiency in albuminoids, fats, carbohydrates, and minerals, and to extend the period of digestion. The effect of lucerne on the flavour of milk is partially overcome when fed in a withered condition, having less volatile constituents and with increased fibre. In this way a degree of maturity is obtained.

We also find, when stock are fed liberally on an immature root crop, such as mangolds, interference with the digestion follows, and the milk suffers. There is evidence to show that fishiness is more troublesome at the height of the grass season, and this has led the writer to associate the taint with the food supply. Again, it is not impossible that some species of weeds possessed with injurious properties might develop in their initial stage of growth certain constituents favourable to fishiness. In milk we can detect strong flavours of the wild mustard, turnip, and marshmallow, and in some districts the manufacture of both butter and cheese gives rise to difficulties peculiar to the district, and which can be attributed to the quality of the herbage.

We are also aware that the milk from cows fed on boggy land is unsuited for the production of high-class butter and cheese, and milk from sewage farms is of a still lower value. In the face of these facts we are sometimes told that food exerts practically no influence over the milk supply.

In the writer's investigations it was further observed that fishiness was pronounced in butter made from cream which contained colostrum, and that a weedy or plant flavour is more readily given to new milk than to milk from cows advanced in lactation. Whatever the influence food may have on fishiness in butter, it was evident that the taint gave great trouble in districts where plant growth was vigorous, and the general supply of herbage succulent and plentiful. The investigations will certainly give support to botanical or chemical changes being associated with the taint.

A valuable discovery was made in the early part of the writer's investigations, and which appeared in a report published by the South Australian Government in May 1900. This showed that a high degree of acidity in the cream was accompanied by fishiness. Many factories have acted on the advice given to churn a mild acid cream, and the results have been very satisfactory.

The following table gives interesting particulars of the best boxes of butter after a period of refrigeration :- -

FISHY BUTTER.

	Flavour.	Hours of Ripening of the Cream.	Growth of Feed in District.
1	Very strong fishy	48	Rank
2	Strong fishy	72	,,
3	,,	48	,,
4	,,	24	,,
5	Full fishy	60	,,
6	,,	30	Partially matured
7	Light fishy	53	Rank
8	Fishy	45	,,
9	Strong fishy	20	,,
	SWEET BUTTER.		
10	Good flavour	26	Partially matured
11	Sweet	28	,,
12	,,	20	,,
13	,,	14	,,
	FRESH CREAM.		
14	Sweet	14	Partially matured
15	,,	14	,,
16	Good flavour	51	,,
17	,,	48	,,

From the table it will be observed that the fishy butters were manufactured from acid creams, and it is worthy of notice that in eight cases out of ten the growth of the herbage in the district supplying the butter was rank and immature. The opposite is seen in the case of the sweet butters. No. 9 of the fishy lot shows twenty hours for cream ripening, but this is accounted for by the use of a starter. No. 16 had the cream preserved in salt before churning, hence the delay of fifty-one hours in ripening, and No. 17 was pasteurised.

An examination of the fishy butters for an alkaline and acid reaction showed that the sweet butter favoured the alkaline test, but all the fishy butters gave strong acid reactions. An acid flavour in the fishy butters prior to refrigeration was also very evident.

Grading of Butter Before and After Refrigeration.—The following gives the grading of the butters. Numbers correspond with the preceding table:—

FISHY BUTTER.

No. of Lot.	First Examination. Maximum of Flavour, 40.		Second Examination.		
	Points Awarded.	Equivalent at 50 Points for Flavour.	Maximum for Flavour, 50.	Difference between Points Awarded	
1	32	40	33	7	Feed rank
2	35	43¾	35	8¾	
3	35	43¾	35	8¾	
4	30	37½	35	2½	
5	30	37½	37	½	
6	30	37½	37	½	
7	34	42½	38	4½	
8	38	47½	37	10½	Feed rank
9	36	45	35	10	

The quality of the bracketed butter was good, more especially Nos. 8 and 9, both samples being entirely free from a foreign flavour. After refrigeration quite a different change took place, as seen from the points awarded in the second examination.

Fishiness developed throughout the period of chilling, which extended to seven weeks; and at the close of that time the boxes were removed to a cool corridor for six days. Here the temperature of the butter averaged 58° F., and upon examination fishiness was noted to be very pronounced.

Some Deductions from the Tests.—The following is an abstract from the report referred to in p. 139.

1. Fishiness was found to be very pronounced in butter manufactured in districts where the herbage was rank and immature. In districts where the herbage was well matured, only a faint indication of fishiness was found.

2. Nearly all the fishy butter was manufactured from cream ripened to a high degree of acidity.

3. All the butter was found to be free from fishiness before refrigeration; after refrigeration nine boxes out of a total of seventeen developed fishiness, which varied from very strong to a light flavour.

4. Discoloration was not observed in any samples beyond what was noted prior to chilling.

5. The fishy flavour appeared to be of equal strength throughout the affected butter.

6. Butter made from one churning, a portion of which was brined and dry-salted, was unaffected with fishiness after refrigeration, while the other portion that was dry-salted only, developed a fishy flavour.

7. The best keeping butter was made from brined grains, no dry salt being used. Preservatives appeared to check fishiness. Cultivations made from very fishy butter did not give colonies productive of fishiness. Certain moulds were found to flourish in butter containing various percentages of boracic acid.

Odium Lactic Mould.—This mould was discovered very extensively in dairy products, and which was reported on as follows :—

1. Bacteriological examinations of sweet separator milk, and buttermilk, proved that contamination followed the use of dirty separators and churns.

2. Cultivations made from sweet milk and cream produced odium lactic moulds.

3. Chemical and bacteriological examinations of water used for washing butter showed that the quality used varied from extra good to very low.

4. When plates were exposed to the air of a dirty milk room, colonies of injurious germs grew abundantly, also different varieties of moulds.

5. From plate and tube cultures serious contamination followed milking with dirty hands and neglect to clean the udders of the cows.

Refrigeration and Flavours

Recognising that temperature plays a very important part in the development of flavours in dairy produce, and following up previous investigations on this subject, an experiment was conducted by the writer six years ago to test the keeping properties of butter at different degrees of cold. The following is taken from the published report :—

Selecting the Boxes.—Forty-four boxes of butter were obtained from different factories, each factory providing four boxes from the same churning, and which were principally selected from export consignments at the cool stores in Brisbane. A very careful examination was made of the quality of each box of butter ; also the weights were taken previous to the produce going into cool storage. In the refrigeration of the butter four rooms were maintained at temperatures of 5° F., 12° F., 18° F., and 25-30° F. It thus followed that butter of the same quality was undergoing the influence of four different temperatures, and the period of chilling was two months, which is more than the time export butter is under refrigeration before reaching London.

These butters represented three grades—first, second, and third—and the selections were made at a period when the brands were showing unusual signs of fishiness.

As one object of the test was to determine the effects of varying degrees of cold on a fishy flavour, one box of butter which showed a trace of fishiness was cut into two parts of 28 lb. each, and stored in chambers at 5° F. and 25-32° F. When the period of refrigeration was over, the first step was to thaw the forty-four boxes to 55° F., at which temperature the average grade of chilled butter gives up its true flavour.

The following shows the varying extent of shrinkage :—

	Before Refrigeration.		After Refrigeration.		Shrinkage.
	Lb.	Oz.	Lb.	Oz	Oz.
Lot 1.—Salt butter	55	4	55	1	3
	56	6	55	5	17
	56	1	55	14	3
	56	6	55	8	14
Total loss, 37 oz., or 9¼ oz. per box.					
Lot 2.—Salt butter	56	14	55	6	24
	56	10	55	14	12
	56	14	55	6	24
	55	12	54	13	15
Total loss, 75 oz., or 1 lb. 2¾ oz. per box.					
Lot 3.—Salt butter	56	7	56	4	3
	56	3	56	0	3
	56	4	55	7	13
	56	6	56	1	5
Total loss, 24 oz., or 6 oz. per box.					
Lot 4.—Salt butter	57	0	56	2	14
	57	0	55	13	19
	57	0	56	0	16
	57	0	55	14	18
Total loss, 67 oz., or 1 lb. (approximate) per box.					

	Before Refrigeration.		After Refrigeration.		Shrinkage.
	Lb.	Oz.	Lb.	Oz.	Oz.
Lot 5.—Unsalted butter	56	12	56	6	6
	56	12	56	2	10
	56	12	56	10	2
	57	0	56	13	3
Total loss, 21 oz., or 5½ oz. per box.					
Lot 6.—Unsalted butter	56	0	55	12	4
	57	0	56	10	6
	56	14	56	10	4
	55	14	55	12	2
Total loss, 16 oz., or 4 oz. per box.					
Lot 7.—Unsalted butter	56	6	56	4	2
	56	8	56	4	4
	56	10	56	8	2
	56	8	56	6	2
Total loss, 10 oz., or 2½ oz. per box.					
Lot 8.—Salted butter	56	10	56	8	2
	55	8	55	6	[illegible]
	56	6	56	3	3
	56	10	56	8	2
Total loss, 9 oz., or 2¼ oz. per box.					
Lot 9. Unsalted butter	56	8	56	6	2
	56	8	56	5	3
	56	4	56	2	2
	56	12	56	10	2
Total loss, 9 oz., or 2¼ oz. per box.					
Lot 10.—Unsalted butter	56	9	56	6	3
	56	10	56	5	5
	56	9	56	6	3
	56	8	56	1	7
Total loss, 18 oz., or 4½ oz. per box.					
Lot 11.—Salted butter	56	9	56	2	7
	56	8	56	4	4
	56	9	56	6	3
	56	8	56	4	4
Total loss, 18 oz., or 4½ oz. per box.					

Lots 10 and 11 came from the same manufacturer, who sent the following report of the butter :—

	Temp. of Cream.	Time of Churning.	Temp. of Water.	Size of Grains.	Time Draining.	First Working.	Interval between 1st and 2nd Working; Temp., 52° F.	Second Working.
		Mins.	Fahr.		Mins	Mins	Hrs.	Mins.
Unsalted	57	30	46°	Peas	30	1	6	2
Salted -	57	30	45°	Peas	30	1¼	6	2¾

It is noteworthy that at the different storage temperatures the butters show in some cases marked differences in weight, which may be attributed to a number of causes. The first four lots suffered the greatest loss through shrinkage, and these were salt butters, in which the moisture was loose or insufficiently incorporated. In cases of this kind the escape of moisture would be increased. In salted butters which had been worked twice, and contained not more than 12 per cent. of water, it is certain that the shrinkage would be small, but the least escape of moisture is accredited to unsalted butter. In unsalted butter the distribution of moisture is very even, and is firmly retained amongst the particles of butter fat, also the butter packs tightly. An unsalted butter may contain as much as 17 per cent. of water without showing any traces of excessive moisture on the trier or in the appearance of the product (see p. 107).

Changes in Flavour.—In the flavour of the butter great changes took place, the extent of which will be more easily followed from the subjoined table :—

<table>
<tr><th rowspan="2"></th><th colspan="2">Before Refrigeration – Flavour, 50 points.</th><th colspan="3">After Refrigeration – Flavour, 50 points.</th></tr>
<tr><th>Points Awarded.</th><th>Defects.</th><th>Temperature.</th><th>Points Awarded.</th><th>Defects.</th></tr>
<tr><td></td><td></td><td></td><td>Deg. F.</td><td></td><td></td></tr>
<tr><td>Lot 1
Salted -</td><td>36</td><td>Stale and inclined to fishiness</td><td>25-32</td><td>32</td><td>Very stale and fishy.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>32</td><td>Very stale and fishy.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>33</td><td>Stale and fishy.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>35</td><td>Slightly stale and fishy.</td></tr>
<tr><td colspan="6">At temperatures of 12° F. and 5° F. the butter was classed as a low second and a medium second.</td></tr>
<tr><td>Lot 2
Salted -</td><td>29</td><td>Very stale and inclined to fishiness</td><td>25-32</td><td>25</td><td>Very stale and very fishy.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>25</td><td>Very stale and very fishy.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>26</td><td>Very stale and very fishy.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>29</td><td>Stale and fishy.</td></tr>
<tr><td colspan="6">At a temperature of 5° the butter showed no difference in quality from the first examination.</td></tr>
<tr><td>Lot 3—
Salted</td><td>44</td><td>Choice</td><td>25-32</td><td>38</td><td>Fishy and slightly stale.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>38</td><td>Pronounced fishiness.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>39</td><td>Fishy.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>41</td><td>Trace of fishiness.</td></tr>
<tr><td colspan="6">This butter improved from a second to a first at a temperature of 5°.</td></tr>
<tr><td>Lot 4—
Salted -</td><td>40</td><td>Slightly sour</td><td>25-32</td><td>34</td><td>Stale and fishy.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>34</td><td>Stale and fishy.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>36</td><td>Stale and faintly fishy.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>39</td><td>Slightly aged.</td></tr>
<tr><td colspan="6">There was also a distinct improvement in flavour at the lower temperatures.</td></tr>
<tr><td>Lot 5—
Unsalted</td><td>42</td><td>Good</td><td>25-32</td><td>38</td><td>Aged.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>36</td><td>Stale.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>40</td><td>Weak.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>42</td><td>Good.</td></tr>
<tr><td colspan="6">At a temperature of 12° the butter benefited to an extent of 4 points, and at 5° it gained a further 2 points, making it similar to the award previous to refrigeration.</td></tr>
<tr><td>Lot 6—
Unsalted</td><td>44</td><td>Choice</td><td>25-32</td><td>32</td><td>Very stale.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>34</td><td>Very fishy.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>38</td><td>Fishy.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>42</td><td>Developing fishiness.</td></tr>
<tr><td colspan="6">The lowest temperature again proved most valuable as a preservative of flavour.</td></tr>
<tr><td>Lot 7—
Unsalted</td><td>42</td><td>Weak</td><td>25-32</td><td>39</td><td>Acidy.</td></tr>
<tr><td></td><td></td><td></td><td>18</td><td>40</td><td>Acidy.</td></tr>
<tr><td></td><td></td><td></td><td>12</td><td>40</td><td>Acidy.</td></tr>
<tr><td></td><td></td><td></td><td>5</td><td>40</td><td>Acidy.</td></tr>
<tr><td colspan="6">There was no change in flavour at the three lowest temperatures.</td></tr>
</table>

	Before Refrigeration Flavour, 50 points.		After Refrigeration Flavour, 50 points.		
	Points Awarded.	Defects.	Temperature.	Points Awarded.	Defects.
			Deg. F.		
Lot 8—Salted	43	Choice	25-32	32	Stale and very fishy.
			18	38	Slightly stale and slightly fishy.
			12	39	Slightly stale and slightly fishy.
			5	40	Trace of fishiness.
Lot 9—Unsalted	35	Stale	25 32	27	Very stale.
			18	29	Stale and fishy.
			12	30	Stale and fishy.
			5	35	Slightly stale and trace of fishiness.
Lot 10—Unsalted	43	Choice	25-32	38	Stale.
			18	40	Slightly stale.
			12	38	Fishy.
			5	34	Very fishy.
At the lowest temperature fishiness developed very strongly.					
Lot 11—Salted	43	Choice	28-32	38	Very fishy.
			18	40	Weak.
			12	42	Good.
			5	40	Trace of fishiness.
Fishiness was again present at a temperature of 5° F.					

Testing a Fishy Box of Butter.—The box referred to, which was equally divided into two 28-lb. parts, was true to the one flavour before going into cool storage. At the conclusion of the experiment the butter which was kept at the higher temperature, 25-32° F., was very fishy in flavour, while that stored at 5° F. was considerably weaker, the distinction being that the former was graded a low third, and the latter a low second.

The deductions to be taken from the experiments are as follow:—

Fishiness. A fishy flavour will develop in both salted and unsalted butter, although in the salted product the flavour is more generally met with. There is, however, evidence to show that a fishy flavour may develop as rapidly in unsalted as in salted butter, or at certain temperatures it may even be stronger in the unsalted butter at the end of a period of refrigeration. No difference in the strength of the flavour could be detected throughout any box of fishy butter, showing that the growth of the flavour was not more pronounced in one part than another. Fishiness was more general and more pronounced in butter which was stored at temperatures of 18° F. and 25-32 F., but the flavour was found in boxes of butter at a temperature of 5° F., and it was pronounced in three boxes of salted and unsalted butter at that temperature. From the test one might infer that it would require a temperature of zero to prevent the development of this ruinous taint in Australian butter.

Stale Flavours.--A striking feature of the experiments were the marked stale and rancid flavours in butters which were kept at a temperature from 25-32 F., and the consistent weakening of the flavour at the lower temperature, with its entire absence at a temperature of 5° F., in butters which were not affected with these flavours at the commencement of refrigeration. Boxes of butter which were either slightly "off" or distinctly "off" in flavour when refrigeration began, did not develop a stronger flavour at 5° F., or, in other words, the affected butter practically came out of the chamber (5° F.) in the same condition as it went in. Out of the 44 boxes tested before refrigeration, stale flavours were found in 16. After chilling to a temperature of from 25-32° F., all but 2 were found affected, the flavour having greatly increased; and 5 boxes which were previously free from stale and rancid flavours became tainted at the above temperatures. At a temperature of 18 F., 5 boxes showed milder stale and rancid flavours. At a temperature of 12° F., 5 boxes were stale. At a temperature of 5° F., 4 duplicate boxes of the 9 which showed a stale flavour at a temperature of 25-32° F. developed the taint, and only 4 out of all the boxes which were stored at

5° F. had varying degrees of staleness, which were noticeable in the butter in three instances before being refrigerated.

Tests have shown that a high degree of bacterial purity in products used in the manufacture of butter did not prevent the butter from developing a strong fishy flavour, and although fishiness is much less prevalent in pasteurised butter, the flavour may be found in a very pronounced form. The writer has already shown that high degrees of acid in cream favoured the fishy flavour, and it is noteworthy that this has recently been confirmed by the New Zealand Department of Agriculture. Reports show that the New Zealand investigators support the chemical theory, although it has been generally accepted in Australia and elsewhere that a microbe is directly responsible for the taint.

Low Temperatures and Fishiness.—These experiments show that excessive cold will arrest the development of fishiness, and this might naturally lead one to believe that bacteriological changes in butter are productive of the flavour. Thirteen years ago the writer was the first to prove that certain plant flavours are absolutely destroyed by refrigeration, and this is fully recognised today in the export trade of Australia. It might also be remarked that weedy flavours impregnate beef, and again refrigeration practically destroys the taint. It is the opinion of the writer that fishiness in butter is largely a chemical change, and the flavour is favoured by a high degree of acid, salt, and a temperature between 30° F. and 40° F. Butters containing from 14 to 16 per cent. water appeared to be more susceptible to the taint.

It must not be thought that only Colonial butter suffers from a fishy taint: it is found in the produce of other countries, and refrigerated English butter may readily develop the flavour.

Blending of Butter

The practice of mixing different grades of butter is called blending. On the Continent the trade is an extensive one; thousands of tons of butter pass through the blending factories every season. In Britain it is also a huge business, and authorities on the subject say that at least 50 per cent. of Australian butter is blended there. So common is the trade becoming that provision shops are said to be equipped with small blending outfits. This chiefly comprises a blender and pounder. In large Continental factories great advances have been made within recent years in blending machinery, and perfection may be said to have been reached in this important department. Blending is a fine art, and one has only to see the grader at work to realise the vital part the science of flavours plays in the blending factory.

Why was Blending Introduced in Britain?

This is an exceedingly interesting part of our subject, and it is hoped no exception will be taken to the answer given by the writer. Speaking from the standpoint of the importer and the blender, there is something to say in favour of the practice, but there is also something to say against it. Let us briefly consider, under the following headings, arguments in support of blending:—

1. Excess of unsaleable butter on the market.
2. Want of uniformity in the quality of butter.
3. Weak-bodied butter.
4. District requirements.
5. Increase of butter substitutes.

1. *Excess of Unsaleable Butter.*—There has always been a large quantity of unsaleable butter made in Britain, and the absence of factory dairying and a sound system of farm instruction has contributed to this weakness. It

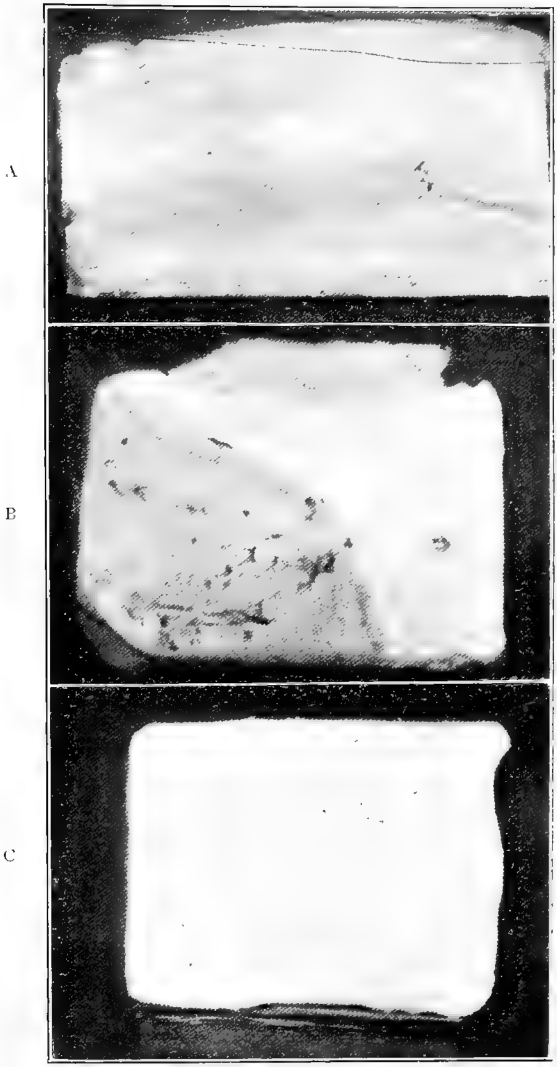


Fig. 20.

A. Section of Imperfectly Blended Butter, showing Different Shades of Colour.

B. An examination of this Sample disclosed Two Distinct Qualities of Butter. Difference in Colour is very marked.

C. Average Sample of Unblended Butter.

All three were purchased from local shops (Thomson).

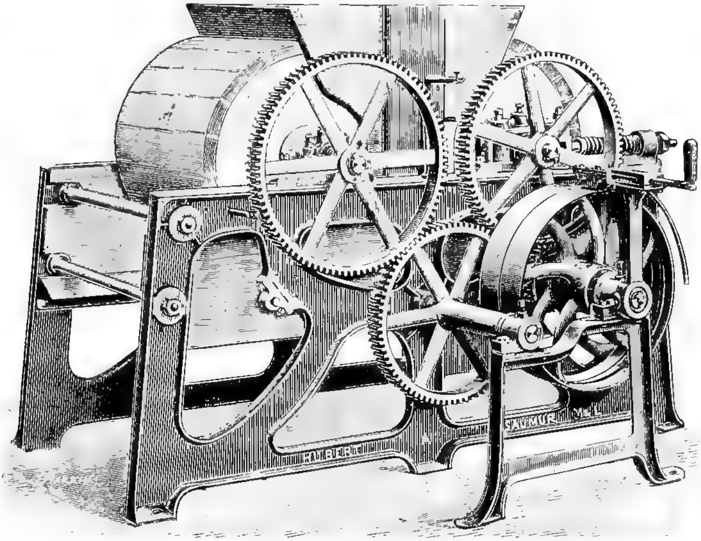


FIG. 21. -Butter Smoothing Machine.

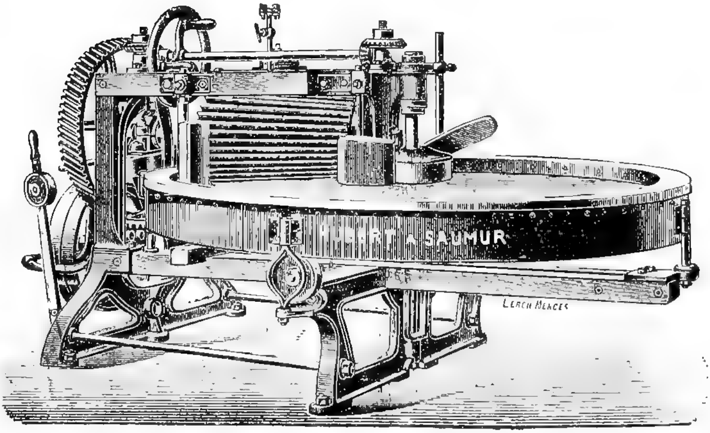


FIG. 22. Blender.

might be asked, what becomes of the inferior English butter that cannot be sold on its merits? It is bought up by the blender; but here it has to be admitted that the quantity of low-grade British-made butter is only a fraction compared with the inferior stuff that is imported from oversea countries.

2. *Want of Uniformity in the Quality of Butter.* It is admitted on all sides that Denmark occupies a pre-eminent position in the export of butter to Britain. She has learned to keep up a continuous trade with Britain for the twelve months of the year, and her interests there are carefully guarded.

Australia has confined her attention to the winter markets only. Uniformity in Australian butter has not come up to expectations of recent years owing to want of legislation to check evils that have sprung up with the rapid development of the industry. Through this cause Australia has suffered very severely in the British market, and it is unfortunate that her errors are not properly understood throughout the Commonwealth.

Denmark realised from the very beginning of her business with Britain that success depended upon the export of a uniformly high-class butter, and this has been maintained till the present day, while other countries have disregarded the danger, with the result that they have invited substitutes to enter into competition with their exports. Denmark holds the British market for choice butter — a standard quality — and not, as we generally hear, through her geographical situation and her winter dairying, which are certainly valuable adjuncts, but because she has all along fully realised that London is not a permanent market for produce of any quality. And let export countries be reminded that whenever inferior produce is exported it should be carefully graded and stamped, to the protection of the export country, and the butter market as a whole.

There is overwhelming evidence to prove that disastrous effects have followed the export to Britain of ungraded and unclassed produce.

3. *Excess of Weak-Bodied Butters.*—Those having experience of different dairying countries and their exports are familiar with the vast differences that are found in the natural flavour, texture, and colour of butter, which are attributed to causes explained in this book. Choice Australian and New Zealand butters are noted for their fine flavour, robust body, and high keeping properties. For this reason they are most valuable for blending with weak-bodied and spongy butters which reach the London market from other countries.

4. *District Requirements.* It is well known that in different counties of Britain, salt and colour are features of butter which influence the sale. The fancy of the public is partly met by the blender, who can provide an article that fulfils the requirements of the district and finds satisfaction with the small grocer, who is the chief patron of the blending factory. The grocer recognises it as a business advantage to have his surplus "off" butter treated by the blender with a better product, thereby enabling him to dispose of what might otherwise be left on his hands. This has been an incentive to the blender.

5. *Increase of Butter Substitutes.*—This exactly shows where the small grocer finds an increasing difficulty in disposing of his surplus stock of butter. Lard, margarine, and other substitutes meet the requirements of the baker and cook with apparently greater profit than butter. It is therefore very necessary for butter manufacturers to realise that the public require a more uniform butter than has been the practice of the past.

Considerable improvement has been made of recent years in the manufacture of smoothing machines, the object being to avoid as far as possible injury to the texture of the bulk butter that is generally treated.

After the butter is smoothed out it goes to the blending machine where inferior flavours that are free are largely removed by spraying with water.

It is suggested that oversea factories should thoroughly wash their inferior butter on a specially constructed worker provided with a sprayer. It would be preferable to do this, than to ship the tainted butter to markets that are already overstocked with this class of produce. And to go further, one might with good cause advise, until more effective remedies are found, that the very faulty produce of oversea dairying countries should be purchased by the State at the port of shipment on the basis of grade, and treated and exported under a descriptive brand. In South Australia, where a Government factory is in operation at the State cool stores, the experiment might be given a trial.

Blended versus *Unblended Butter.*—Blended butter, being a mixture of two or more classes of butter, possesses a superior flavour to the poorest quality used in the blend, but the mixture has a less attractive flavour and a lower keeping property than the choice butter upon which its value chiefly depends. It is therefore necessary for the blender to purchase the finest quality to mix with inferior butter, otherwise his object would be defeated. Turning to texture, we find it inferior in the blended article, which is the result of the severe treatment the butter receives in the process of mixing. But the consumer does not appear to take any exception to this: the ease with which blended butter spreads on the bread would seem ample compensation for the injury to texture.

Is the World's Butter Production in Danger?

The Colonies and foreign countries are the source of Britain's butter supply, and statistics show that the exports are declining. This opens up the question as to the cause. Is it due to the limit having been reached in manufacture? That is not the case, for there are tremendous resources in Australia, Siberia, and the Argentine for the dairying industry. Denmark, however, may be said to have reached high water mark in the export of butter. Competition from Canada is no longer active because of her own demands. Ten years ago over 13,000 tons of butter were exported to England; for the year ending last June no shipments were made from Canada. Showing the position of butter exports to Britain, in 1903 the total was 176,320 tons; in 1912 this fell to 147,338 tons, or a reduction of 28,982 tons over a period of ten years. The grand total, which includes Colonial butter, was 200,186 tons in 1903, and 199,310 in 1913.[1] Unfortunately Australia and New Zealand have fallen off by fully 10,000 tons for the last year, but the position of foreign countries has generally improved, principally Russia and France, whose increase is a little short of this quantity.

Is the Market Militating against Oversea Dairying?

The price of butter has risen of late years. What, then, is the cause of the decline in exports? The writer will venture to give a brief answer to the question. Droughts in Australia cause a fluctuation in the butter exports, and the exploiting of new markets in South Africa, the Far East, and elsewhere, and a greater consumption within the Commonwealth, have had a lowering effect on shipments of butter to Britain. In other parts of the world the vagaries of the season have likewise been a factor in the export of butter, and many factories are turning their attention to cheese; but there are other reasons responsible for the falling off of exports. The growing population of Britain, without any corresponding increase in the manufacture of home butter, should naturally lead to a brisker demand for the imported product. This has not been the case. Unfortunately, butter is not always sold according to its flavour and general qualities. The market is forced against quality, and against the pockets of the public, to the detriment of dairying. This has brought about a tremendous change in the distribution of butter.

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[1] These figures are for the year ending in June.

Famine prices for butter, which raged in 1912, compelled consumers to divide their attention between the blended article and margarine. Every time the market is forced above its true butter value, the margarine manufacturer triumphs. In the hot months of the year the weak consistency of margarine is a factor against its sale, which brings it into greatest conflict with the winter butter trade. This, however, may be largely corrected in the manufacture by the addition of a higher proportion of hard fats. The public have grown to like this substitute, and each day brings fresh converts on its side. It cannot be denied that the quality of the best margarine is high, and the price is within the means of the poorest consumer. It is, therefore, to be expected that the public will not pay fictitious prices for butter of doubtful quality out of sentiment for the dairying industry. Margarine comes into active competition with the lower grades of butter, but the time is fast approaching when the best brands of margarine will be on a level with first class-butter. This is already happening by the addition of from 6 to 10 per cent. of the choicest butter to the best margarine. The following tables supplied by the Board of Agriculture will show the relative imports into Great Britain of butter and margarine for the past three years.

Quantity of butter and margarine imported into the United Kingdom in each month from January 1910 to October 1912 inclusive. (From the monthly accounts relating to trade and navigation of the United Kingdom)—

BUTTER

	1910.	1911.	1912.
	Cwt.	Cwt.	Cwt.
January	399,857	451,587	428,063
February	333,405	393,847	360,356
March	357,482	416,061	353,255
April	385,953	365,034	294,327
May	388,211	370,371	326,985
June	401,994	400,263	329,116
July	347,775	371,362	383,314
August	368,850	342,117	330,141
September	307,326	267,360	248,764
October	292,628	301,196	299,942
November	319,221	302,247	296,462
December	422,837	321,511	348,434

MARGARINE

January	77,783	68,027	99,477
February	98,451	63,037	116,005
March	127,197	70,766	118,193
April	122,564	65,842	115,397
May	111,210	72,276	116,523
June	85,408	64,337	97,042
July	83,972	63,574	110,972
August	88,181	84,469	103,525
September	80,147	74,037	103,490
October	77,591	100,942	121,109
November	84,291	102,359	119,840
December	83,821	114,739	130,854

In Messrs Weddel & Co.'s annual report of the dairy produce trade for the year ending 30th June 1912, it is pointed out that there was an increase of 15,014 tons of margarine imported into Great Britain, which was 33 per cent. above the previous year's figures. The position has not been wisely considered by the dairying industry as a whole, and it will come as a surprise to many people to be told that the imports of butter into the United Kingdom in 1912 showed a decrease of 18,000 tons against 1911, while the increase of margarine totalled 17,500 tons. With a heavy annual production in the United Kingdom added to this, probably now over 2,000,000 cwt., it will be more fully recognised that the butter trade has a very vigorous and healthy competitor. In addition to the above it might be pointed out that for the year ending June 1911, 45,000 tons of margarine were imported into the United Kingdom, and in 1913 the figures rose to 71,000 tons. In 1904 (year ending June) the total imports of butter amounted to 218,943 tons, and in 1913, or nine years later, this fell to 199,310 tons. Margarine is now found in good restaurants and hotels throughout Britain, as well as on the tables of those well able to afford the choicest butter on the market. This year the demand for margarine is exceeding all records. We are told there is room in the world for both the dairying industry and margarine factories, but it cannot be too forcibly stated that no longer is there room for inferior butter; it has polluted the market too long. British countries participating in the export of inferior butter should act promptly and decisively, and realise once for all that Britain is not a dumping ground for faulty surplus produce. The writer has vigorously expounded this view for many years, and has held up the Danish dairy policy, which is reiterated in this book, as an example for British countries to follow.

In view of what has been said, the writer gives the following additional tables from the reports of Messrs Weddel & Co. and the returns of the Board of Agriculture, after which the subject of margarine will again be considered.

IMPORTS OF BUTTER FOR THE TEN YEARS ENDED 30TH JUNE 1913

Year Ended 30th June.	British Dominions.				Foreign.												Grand Total.
	Australia.	Canada.	New Zealand.	Total British.	Argentina.	Denmark.	France.	Germany.	Holland.	Italy.	Norway.	Russia.	Sweden.	U.S. America.	Other Countries.	Total Foreign.	
	Tons	Tons.	Tons.	Tons.	Tons	Tons.	Tons.	Tons	Tons.	Tons.	Tons.	Tons.	Tons	Tons.	Tons.	Tons	Tons
1904	19,655	9,879	15,836	45.370	4.435	88,151	22.223	211	15.804	3.396	1.345	24.849	10,871	2,190	98	173.573	218,943
1905	23,368	12,847	15.667	51,882	3.575	83.520	17.055	89	10,845	2,917	1.545	20,159	9,708	2.307	235	152,015	203,897
1906	26,950	15,145	15.177	57,272	2,665	81.261	17.405	449	9.887	2,257	1.410	25,327	8.810	8.445	305	158.221	215.493
1907	34,023	8,220	14.852	57,095	2.410	87,273	13.316	444	8,707	1,761	1.344	32,425	10,882	3,367	253	162.182	219.277
1908	22,396	1,862	11.492	35.750	2,430	91,248	16,045	249	9,562	949	1,263	30.487	11,118	884	249	165.384	201,134
1909	16,180	2.386	13,631	32,197	4,475	93,050	19,875	277	10,490	1,027	1,520	32.612	13.236	1,201	606	178.378	210.575
1910	28,770	1,162	16,705	46,637	2.024	84,632	20,212	35	8,270	555	1,210	29,426	15.352	4	1,707	164,327	210.964
1911	44,395	776	15,852	61,023	932	88.379	14,665	231	6,272	281	1,295	30,201	18,671	538	302	161,707	222,790
1912	33,677	2,997	16,183	52,857	2,603	80,398	8.333	74	5.337	76	1.615	30,757	17,123	795	227	147.338	200,195
1913	26,414	...	13,416	39,830	4.400	82,546	13.167	86	6,584	56	1.211	35,194	16,000	...	236	159.480	199,310

MONTHLY AVERAGE OF WHOLESALE TOP PRICES OF "CHOICEST" QUALITY SALTED AUSTRALIAN, NEW ZEALAND, AND CANADIAN BUTTERS FOR THE FIVE YEARS ENDED JUNE 1909-1913.

Country.	Year.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	Year's Average.
		Cwt. s. d.	Cwt. s. d.	Cwt. s d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.
Australia	1908-1909	109 4	...	...	119 7	116 6	106 9	108 0	106 0	103 3	98 0	100 6	99 6	106 9
	1909-1910	100 0	...	112 0	114 0	115 6	108 0	111 6	119 0	123 6	116 5	104 6	103 6	111 9
	1910-1911	103 2	...	116 0	113 7	107 0	103 5	104 6	102 0	102 0	102 5	99 6	100 6	105 0
	1911-1912	108 6	118 6	125 2	132 0	129 0	128 0	132 0	130 0	124 10	114 6	109 2	109 0	121 9
	1912-1913	108 6	112 10	113 6	116 6	115 7	117 0	112 5	111 0	112 0	110 0	108 5	107 6	112 1
	Average	105 11	115 8	116 8	119 2	116 9	112 8	113 8	113 7	113 1	108 3	104 5	104 0	111 6
New Zealand	1908-1909	114 10	116 0	116 0	122 3	120 9	111 3	114 10	109 3	106 3	100 0	104 6	105 6	111 9
	1909-1910	100 0	...	118 0	118 5	119 0	112 0	115 0	120 0	125 6	118 5	108 6	108 9	115 5
	1910-1911	109 4	...	116 0	114 0	111 0	107 7	108 0	106 0	100 0	108 10	107 0	106 0	109 1
	1911-1912	...	...	...	...	131 0	132 0	134 9	132 9	128 2	117 6	114 0	115 0	125 8
	1912-1913	114 8	...	...	...	119 0	123 6	117 0	117 0	120 0	116 0	114 5	115 0	117 4
	Average	111 3	116 0	116 8	118 3	120 2	117 3	117 11	117 0	117 2	112 2	109 8	110 0	115 10
Canada	1908-1909	117 0	117 6	116 3	118 5	...	...	...	...	...		...	...	...
	1909-1910	...	...	115 0	116 0	...	...	...	...	...	...	...	...	...
	1910-1911	...	...	116 0	...	...	...	...	...	...	...	...	...	...
	1911-1912	...	...	...	...	...	...	...	...	...	...	...		...
	1912-1913	...	...	...	...	...	...	...	...	...	...	...	...	...
	Average	117 0	117 6	115 9	117 3	...	...	...	...	...	...	...	...	...

MONTHLY AVERAGE OF WHOLESALE TOP PRICES OF SALTED DANISH, SIBERIAN, AND FRENCH BUTTERS FOR THE FIVE YEARS ENDED 30TH JUNE 1909-1913.

Country.	Year.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	Year's Average.
		Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. d.	Cwt. s. g.	Cwt. s. d.	Cwt. s. d.
Denmark	1908-1909	121 7	122 0	121 3	129 2	125 0	115 9	116 0	117 9	116 0	108 10	113 9	112 0	118 3
	1909-1910	114 0	106 0	121 9	129 7	130 9	126 2	122 6	128 3	132 3	124 2	115 0	115 9	122 2
	1910-1911	115 5	115 9	117 9	118 0	116 6	116 0	117 0	121 0	120 6	117 2	110 3	113 3	116 8
	1911-1912	120 0	130 6	136 5	144 0	137 0	138 17	137 3	137 0	137 4	126 9	118 9	122 3	132 2
	1912-1913	123 0	130 2	131 3	132 0	130 5	131 9	128 7	131 6	132 6	121 9	115 2	119 0	127 3
	Average	118 10	120 11	125 8	130 7	127 11	125 10	124 3	127 1	127 9	119 9	114 7	116 5	123 4
Siberia	1908-1909	109 7	110 0	109 0	111 7	112 0	104 6	104 0	114 0	104 0	98 10	100 6	101 6	106 7
	1909-1910	101 2	103 6	105 6	108 0	111 0	110 5	109 0	117 6	122 6	117 6	104 6	101 6	109 4
	1910-1911	100 5	104 6	108 0	107 7	104 6	102 0	103 6	104 0	106 0	102 5	99 0	100 6	103 6
	1911-1912	106 5	115 0	121 2	125 6	123 0	126 0	130 6	130 0	126 10	115 0	109 6	108 10	119 10
	1912-1913	105 6	108 0	111 0	113 6	110 0	112 0	111 2	112 0	112 0	109 6	103 2	101 6	109 1
	Average	104 7	108 2	110 11	113 3	112 1	111 0	111 8	115 6	114 3	108 8	103 4	102 9	109 8
France	1908-1909	112 0	111 6	110 6	115 2	114 0	113 0	115 7	104 0	118 0	112 10	105 0	106 6	111 6
	1909-1910	107 7	106 6	113 0	114 5	119 0	117 7	121 3	132 0	133 0	128 10	112 0	109 0	117 10
	1910-1911	110 0	110 0	117 0	118 0	117 0	125 0	126 0	124 6	126 0	122 0	115 0	117 0	119 0
	1911-1912	122 9	136 0	135 7	142 6	141 6	146 0	146 0	149 0	150 0	136 0	124 0	125 3	138 4
	1912-1913	122 0	123 0	121 0	121 6	123 2	131 0	128 10	135 0	136 0	130 0	120 5	114 0	125 6
	Average	114 10	117 5	119 5	122 4	122 11	126 6	127 6	128 11	132 7	125 11	115 3	114 4	122 5

From the Board of Trade returns showing the quantity of butter imported monthly into the United Kingdom from the British Dominions and from foreign countries for the year 1912:—

	BUTTER.													
	BRITISH DOMINIONS.				FOREIGN COUNTRIES.									GRAND TOTAL.
Date.	Australia.	Canada.	New Zealand.	Total.	Argentina.	Denmark.	France.	Netherlands.	Russia.	Sweden.	United States.	Other C'ntries.	Total.	
1912.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Jan.	120,875	24	73,796	194,695	7,672	152,415	9,378	5,050	16,497	32,740	1.783	7,833	233,368	428,063
Feb.	98,948	1	62,074	161,023	10,355	128,788	8,554	4,579	16,972	30,439	773	4,873	205,333	366,356
Mar.	92,798	...	61,427	154,225	9,454	126,966	6,873	4,494	19,617	26,360	16	5,250	199,030	353,255
April	14,967	...	42,550	57,517	6,499	139,771	8,865	7,226	40,161	30,372	22	3,894	236,810	294,327
May	55,253	...	27,899	83,152	1,621	126,573	23,610	19,059	43,514	24,842	...	4,614	243,833	326,985
June	39,197	...	7,956	47,153	...	139,626	25,527	12,747	76,541	25,457	2	2,063	281,963	329,116
July	7,996	...	298	8,294	...	151,865	28,530	13,663	144,622	32,559		3,781	375,020	383,314
Aug.	1,756	...	493	2,249	...	124,924	25,228	11,751	138,769	23,861	...	3,359	327,892	330,141
Sept.	1,051	...	63	1,114	...	117,197	26,789	10,348	66,668	24.860	...	1,788	247,650	248,764
Oct.	3,231	2	268	3.501	3,314	143,038	37,170	11,332	69,287	30,287	...	2,013	296,441	299,942
Nov.	41,996	...	30,042	72,038	10,395	116,063	27,811	6,225	36,483	28,517	...	3,930	224.424	296,462
Dec.	63,185	...	42,146	105.331	17,934	150,822	18,317	7,242	14,519	29,720	...	4,549	243.103	348,434
Total	541,253	27	349,012	890,292	67,244	1,618,648	246,652	113,716	683,650	335,014	2,596	47,947	3,114,867	4,005,159

From the Board of Trade returns showing the total quantity of butter imported into the United Kingdom in the months of December 1910-1912, and for the twelve months ended December 1910-1912:—

Country	Butter.					
	Month ended 31st Dec.			Twelve Months ended 31st Dec.		
	1910	1911	1912	1910	1911	1912
British Dominions—	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Victoria -	77,980	71,968	39,175	307,929	441,481	264,552
New South Wales	29,244	29,556	15,116	217,780	281,588	186,695
Queensland	10,657	2,652	8,894	113,384	151,330	90,036
New Zealand	66,594	21,862	42,146	362,674	276,446	349,012
Canada	...	17	...	16,805	61,936	27
Total -	184,475	126,055	105,331	1,018,572	1,212,781	890,292
Foreign Countries—						
Russia -	18,958	18,540	14,519	584,040	638,284	683,650
Sweden -	29,117	26,811	29,720	354,684	360,357	335,014
Denmark -	143,132	118,927	150,822	1,726,091	1,707,178	1,618,048
Netherlands -	7,555	5,130	7,242	154,537	104,655	113,716
France	18,911	8,660	18,317	361,249	171,080	246,652
United States	1	1	...	756	23,052	2,596
Argentina	9,250	10,808	17,934	65,944	24,209	67,244
Other Countries	11,438	6,579	4,549	68,666	61,096	47,947
Total -	238,362	195,456	243,103	3,306,967	3,089,911	3,114,867
Grand Total -	422,837	321,511	348,434	4,325,539	4,302,692	4,005,159

Table showing the totals of butter and cheese imported into Britain in 1912 from Australia, New Zealand, and Canada, and the difference for each month of the previous year:—

YEAR.	TOTAL.	Difference from previous year.	TOTAL.	Difference from previous year.
1912.	Cwt.	Cwt.	Cwt.	Cwt.
January -	197,107	+ 5,588	123,092	+ 34,731
February	154,296	36,278	106,723	+ 8,438
March	150,296	40,216	87,336	− 6,494
April	58,248	− 38,525	84,947	+ 21,283
May	97,580	− 22,679	85,471	− 3,433
June	20,089	66,419	182,899	+ 17,255
July	11,411	− 28,270	281,184	32,959
August -	1,397	− 18,919	212,192	+ 4,789
September	1,377	24,819	233,429	− 17,096
October	5,362	35,921	209,733	− 12,537
November	79,546	− 4,164	159,701	− 14,829
December	107,445	36,611	131,202	+ 27,815
Total for 12 months	884,154	− 347,233 Butter.	1,897,909	+ 26,963 Cheese.

Margarine

Reference has been made to the causes which are chiefly responsible for the increased demand for margarine. One that stands out prominently is the inequality of butter, which has been referred to. In asserting that quality is being neglected one naturally asks for proof. Go to our distributing centres of dairy produce in Britain and to our shops, and what do you find? Marked irregularity in the general quality of butter, and a faulty distinction between price and flavour.

Unfortunately, margarine lends itself for purposes of adulteration, and this may develop into a trade, as fairly high percentages of neutral fats used in the manufacture of margarine can be added to butter with impunity. But the margarine manufacturer does not encourage the adulteration of butter; he wishes to have a clear distinction made between the two products, in order to protect the interests of his business, and no doubt he would welcome reforms in the retail shops. It may be said that one evil is in the hands of consumers, who frequently eat margarine believing it to be choice butter, and the responsibility of this is said to largely rest with those who make the purchases on behalf of households. There are, however, other dangers that might be mentioned, and which call for very careful consideration.

Growing Consumption at Home and Abroad.—In a report of the Department of Agriculture of Canada for 1912 the subjoined appears: "The high cost of butter in the United States was, of course, a fine thing for the manufacture of margarine. It stimulated its production wonderfully. For instance, in the month of February the Chicago district produced 7,892,659 lb., and March, 6,725,011 lb. Of the latter quantity, 229,051 lb. were coloured, and paid the tax of 10 cents per lb."

In Denmark there are twenty-two factories producing over 63,500,000 lb. of margarine per annum, and the imports total about 2,000,000 lb. As the law prevents the export of margarine from Denmark its use is, therefore, confined principally to Copenhagen and other large cities. It is stated that twenty years ago the consumption of margarine in Denmark was equivalent to 7½ lb. per head of the population; in 1912 it was close on 30 lb.

According to inquiry, the total imports of margarine into Germany in 1912 amounted to 43,560 lb. Total production was 400,000,000 lb. Estimated consumption per head of population of 65,000,000 is a little over 6 lb.

From the figures and information obtained the following is an approximate comparison of the consumption of butter and margarine per head of the population of Great Britain and Ireland.

Taking the years 1910 and 1912 for comparative results, we find in the former that 15.77 lb. of butter were consumed per head of the population, or 4¾ oz. per week, and 4½ lb. of margarine, or 1.3 oz. per head per week.

In 1912 the consumption of butter fell to 14.9 lb., or 4⅕ oz. per week, and margarine increased to 8.93 lb., or 2.73 oz. per head per week. This gives a ratio for 1910 of 1 lb. of margarine to 3.4 lb. of butter, and for 1912 1 lb. to 1.7 lb. of butter. Of the quantity of butter consumed in 1912, it is stated that about 40 per cent. was blended, leaving 60 per cent. for consumption as it came from the butter factories and farms.

It might be mentioned that the consumption of butter in Britain in 1903 was, according to the *Journal* of the Royal Statistical Society of 1904, 18½ lb. per head. Margarine is not given.

It is reported that there will be a shortage of butter this year, also of oils and vegetable fats, but lard will be in excess of demand.

The expansion of the margarine trade has caused a heavy drain on the raw material, but this is likely to be met by a marked diminution in the use of vegetable fats by soap works. It is asserted that an important discovery of some years ago will be responsible for a revolution in the fat market, and that margarine manufacture will receive a very great impetus. This discovery is the hardening of liquid oils by hydrogen. By the process, cotton oil, whale oil, and other strong-smelling oils of the latter class are solidified, and the bad flavours eliminated. Soap manufacturers should be in a position to substitute these fats for the more expensive copra oil and cotton oils used in manufacture.

Copra in Germany increased from 141,049 tons in 1910 to 164,436 tons in 1912. The price of copra oil at Liverpool was about £40 per ton in 1912, or cheaper than it was in 1910.

As this is one of the most expensive oils used in the manufacture of margarine, it will be observed how cheaply margarine can be produced compared with butter.

IMPORTS OF COCOANUT BUTTER AND COCOANUT OIL INTO THE UNITED KINGDOM

Years.	Cocoanut Butter.	Unrefined Cocoanut Oil.
	Cwt.	Cwt.
1907	118,903	357,815
1908	203,077	555,325
1909	177,085	502,408
1910	500,209	539,686
1911	588,897	545,960
1912	599,826	633,363
	An increase since 1907 of 24,046 tons.	An increase since 1907 of 13,777 tons.

In 1905 Australia sent a total of 38,300 tons of tallow to the United Kingdom, and in 1912 this was increased to 58,500 tons.

New Margarine and Butter Laws Necessary.—Amongst the poor may be found the bitterest opponents of margarine, and it is possible they are the chief victims of the inferior butter traffic. In shops where butter and margarine are sold, a special counter should at least be provided for each product. At present margarine and butter are to be found on the same counters of shops, with only the label or wrapper to distinguish the one from the other. It is, therefore, reasonable to suggest that errors in the sale of butter and margarine are subject to occur.

Inspection of Margarine Factory.—England claims to have the largest and best equipped margarine factory in the world. It is situated at Southall, a few miles from London, and was founded in 1894 by Otto Monsted, who is one of the pioneers of the margarine trade, and who started a well-known factory in Denmark as early as 1878. His first factory in England was founded at Godley, Cheshire, in 1889.

Of recent years the company's works at Southall have been greatly extended to cope with the increased demand for margarine, and the buildings now cover an area of fifteen acres. Approximately one thousand hands are employed in two shifts (one for day and one for night), to deal with the present output of 1,000 tons of margarine per week.

A brief explanation of the manufacture of margarine at this factory will be of interest.

As is well known, a butter-flavoured margarine cannot be made without milk, and the Southall works receive a large quantity daily. The milk is sent direct from the farms by special trains to the company's private sidings. Before delivery is taken, each churn is examined for flavour by specially trained men. Samples of the milk are taken and submitted to a chemical and bacteriological examination. In this way a complete control of the supply is kept.

The milk is at once dealt with in a large and modern dairy, which forms a special part of the factory. It is heated to about 104° F. before passing through the separator. The cream is either skimmed to a 50-52 per cent. fat, cooled to freezing point, and sold in London as thick cream, or to about 25 per cent. fat, pasteurised, and cooled to ripening temperature for churning into butter.

The vats used for ripening the cream are of tinned iron, fitted with combined agitators and coolers. These thoroughly blend the cream with the starter, and regulate the temperature during ripening; also the agitators are capable of cooling the cream to the proper degree for churning in a few minutes.

An aluminium churn of great capacity has been installed, and from the success of this innovation there is cause to think that aluminium will revolutionise the musty-flavoured wood of the average churn in use to-day.

The separated milk is pasteurised at 174° F., and is immediately cooled in a thin film to about freezing point. Afterwards it is stored at this temperature in large tinned iron tanks until required for ripening.

For the manufacture of margarine separator milk is subjected to special treatment, so as to impart to the margarine the taste and flavour of butter. For this purpose special cultures are prepared in the factory laboratory. The latest scientific invention in connection with starters is a propagator which is installed in the factory, and which promises to revolutionise the practice of ripening.

When the milk is ripe, which is chiefly determined by the alkaline test, and after being cooled to a suitable temperature, it is incorporated with the liquid fats. These comprise vegetable and animal oils and fats. Of the former there is cocoanut oil, peanut oil (arachis), and cotton-seed oil, and the animal fats are oleo and neutral lard. The fats are mixed in a liquid state and coloured with ordinary annatto preparations.

The blend of milk and fat is run between refrigerated drums or large rollers, where it is at once crystallised and scraped off by knives, after which it descends into small waggons in thin sheets of fat. The margarine remains in the waggons for some hours to "ripen." It is afterwards worked and salted in the kneaders, which resemble churns in appearance. From there it goes to the blending machines to be thoroughly mixed. The margarine is now made up into rolls or packed in boxes of varying size according to market requirements. By means of automatic carriers the boxes are conveyed to the refrigerated chambers, and from there gravity conveyors are used to transfer them to the company's railway sidings, which can accommodate over 200 trucks.

The hygienic installations and sterilising arrangements are largely developed throughout the works. The atmosphere in the rooms is renewed thrice hourly with the outside air, which is purified and introduced into the respective rooms at a suitable temperature and degree of humidity. The floors and wooden utensils are all washed with lime and soda solutions, and finally disinfected with a special chemical preparation. The waggons used for the conveyance of the raw and manufactured materials are sterilised after each delivery, and it might be mentioned with interest that wooden utensils are not appreciated by the company, on account of the danger of harbouring yeasts and moulds.

To the factory is attached a large laboratory, fitted with the most recent scientific instruments and apparatus. A staff of chemists are employed by day and night. Of the numerous tests used in the laboratory attention might be drawn to the combined reductose and fermenting test which is applied daily to milk received from the farms.

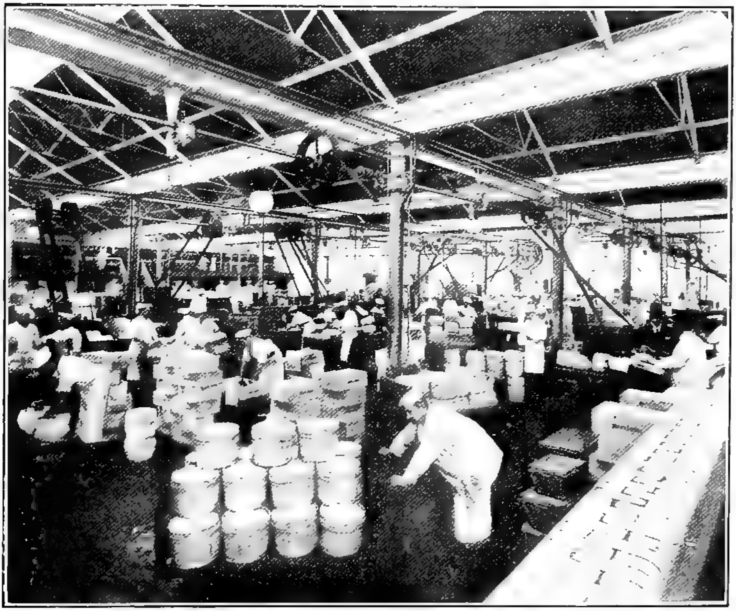


FIG. 23.—Packing Margarine at Southall Factory, England (Otto Monsted Ltd.).

Tubes containing 50 c.c. of milk, coloured with 1 c.c. of methylene blue, are placed in an incubator at a temperature of 101-104° F., the object being to hatch whatever organisms are contained in the milk. If the milk becomes bleached in seven hours, or shows defects in curdling, the cause is assigned to unwelcome organisms, and which results in a searching chemical and bacteriological analysis of the supply from the farm. Analyses of butter and margarine are carried out by inoculating culture media with the samples, which are afterwards placed in an incubator for the organisms to develop. Microscopic examination decides their usefulness or otherwise.

The writer's inspection of Southall factory has more clearly revealed the appalling weaknesses of "up-to-date" butter-making.

Tests for Margarine

The writer has given this subject close attention, and has made numerous practical tests to determine upon what common grounds margarine may be detected from genuine butter. Margarine in appearance may be said to be identical with commercial butter. It is generally of a pale yellow colour, much resembling the Danish article. In flavour there is a certain relationship to mild pasteurised butter. One might be tempted to say that the margarine manufacturer has copied the characteristics of Danish butter. Let us briefly consider a simple and practical way of distinguishing margarine from butter. We know, from what has already been written, that margarine is the product of vegetable and animal fats, and it can be delicately flavoured with a pure culture of lactic organisms. When a comparison is made between the two products we find that both have a different consistency. "Nuts and Milk" margarine is more soluble than butter, and to prove this in a simple way, let the reader bring a sample of margarine and a sample of butter under the influence of the palate. He will find differences which, according to the present composition of the product, are useful in distinguishing it from butter.

After rinsing out the mouth with water, take a small perfectly clean knife and remove a quantity of margarine from the centre of a ½ lb. block. This will ensure a true sample.

Immediately the margarine comes in contact with the mouth a coldish, watery feeling is given, and if held firmly between the tongue and the roof of the mouth this will be more in evidence. When searching for the flavour by movement of the sample in the mouth the solubility of margarine is shown by the quickness with which it dissolves. What has been described is a physical property of margarine detected by the palate. Let us now consider the flavour. Generally speaking, margarine preparations are somewhat insipid, and there are few taints associated with the product compared with butter. The coldness given to the mouth seems to take away from the first flavour. The last flavour will vary according to the quality of the margarine. If a pure culture has been used, a fine delicate aroma may be detected. Tests have shown that the culture flavour disappears from margarine upon exposure of the product at ordinary room temperatures for periods ranging from three to five days. These tests were confined to pound and half-pound samples. The strength and proportion of the culture used will play an important part in the "fixity" of flavour. The writer has proved by the palate, which is the only flavour test, that animal and vegetable fats, no matter how pure and finely divided they may be, will not retain a lactic acid flavour so well as pure pasteurised butter, because the relationship between the fats of margarine and the lactic flavour is too much opposed.

Turning to texture, there is practically no distinction between the grain of the best margarine and the grain of the average brand of butter. In body there is a difference, margarine being more open, while the butter is close and compact. The former feature may be tested in the ordinary way, the latter by the use of a sharp knife which, when passed through a ½ lb. of margarine, will make an easy and comparatively clean cut. Particularly in the case of unsalted butter, the greater viscosity of the milk fats, and blended as they are with a small proportion of casein, prevents so easy a movement of the blade, and the butter fats will adhere more to the metal. In making this test both samples must be at the same temperature.

In returning to the palate test, we shall apply it in the same way to a sample of butter similarly taken to the margarine. The butter will give a warmer and a more fatty feeling in the mouth, and it will not dissolve so readily. The flavour will be creamy, and distinct from the average brand of margarine. With oleomargarine, however, it may be observed that the differences are not so marked as in the case of margarine that contains high percentages of vegetable fats.

Boiling Water Test.—Take two sherry glasses and fill each with boiling water. Remove a sample of margarine from the heart of the block of about the size of a hazel nut. Hold it a couple of inches over the glass of boiling water, and let it drop into the centre of the glass. Note very carefully how quickly the margarine dissolves, and that the fats spread out in a characteristic way round the sides of the glass. In the clear water space, colonies of fat will be observed that soon lighten in colour and appear to crystallise at the falling temperature. Take a sample of butter, and drop it into the other glass of boiling water in exactly the same way as the margarine. It will be seen to descend further into the water for obvious reasons. Nothing will be more striking than the slower melting of the butter fats compared with the margarine, and the absence of colonies in the clear water space. The fats will form a somewhat different shape round the sides of the glass to that seen in the margarine glass.

Allow the glasses to stand for a few hours until the fats have hardened. Get ready two thoroughly clean sherry glasses, and after breaking the fats into small pieces, pour the content of each glass into the fresh glasses. The margarine sample will quickly settle, leaving the water clear, while the butter will give a milky water that remains permanently opaque.

In making this test the operator is cautioned not to prepare the samples in any way ; they must be cut from the margarine and butter without interfering with the texture, and each sample should be similar in size and shape.

In comparing margarine with butter in which the colour varies very interesting observations may be made, and by the test it is possible to distinguish Danish butter from the butters of other countries, also blended from an unblended product. Those interested in the test, and are anxious to benefit by it, should first obtain samples of margarine, blended and unblended butters, and test each as directed. In this way the operator will become acquainted with the features that distinguish one from the other.

Melting Point of Margarine.—This can be raised or lowered according to the relative proportion of fats used in the manufacture of the product, but the fact remains that the fats are attacked by heat in a way that is readily distinguished from butter, as will be understood from the tests.

Classes and Qualities of Margarine.—The former may be divided into oleomargarine, vegetable margarine, and a preparation of both. In accordance with modern manufacture the "ripening" of the fats is done by the use of a starter of the choicest flavour, and in the preparation of starters, margarine manufacturers have absolutely outclassed the dairying industry. We have, therefore, a quality of margarine that very closely resembles butter, and the similarity in flavour and consistency is more perfectly obtained by the addition of choice pasteurised butter to the margarine, which, however, must not exceed 10 per cent. as prescribed by British law. Margarine will rise in value as the demand increases, and before long we may expect to see on the market different qualities ranging in price from 6d. to 1s. a pound. There are also cooking and baking margarine, which now find a ready sale.

In comparing defects in butter with those of margarine, rancid, cheesy, mouldy, and acidy flavours are found in the latter product. The fewer taints gives it an advantage over butter.

Keeping Properties.—It is generally believed that margarine has low keeping properties, in other words it deteriorates quickly. This is not the case with certain grades which are now on the market. Margarine can be made to keep for months at cool temperatures and without the use of preservatives. Great developments may be expected in this direction.

Marketing of Butter.—Reference has been made to excessively high prices of butter. Fictitious figures should not be demanded by the factories, and the disposal of produce on consignment is recommended. It is suggested, and not without good cause, that State banks should be established in the Colonies, to enable factories to withstand the temptation of selling their produce outright, and for purposes of equipment and the general improvement of their exports. Were this question gone into with unbiased minds, and a broad and natural view taken of it, factories would come to only one conclusion, that the sooner reforms in the selling of their butter are put into practice the better for their future. It can no longer be concealed that the butter trade of Australia with Britain is in danger, and the situation should be faced now, and remedies found.

It has been suggested that standard prices should be instituted for wholesale butter, and that the retail market should be kept as near as possible to a price that will commend the approval of consumers. No doubt fluctuation in prices, with its dangers, will be inevitable until butter is more uniform in quality, and more practical schemes are found for better distribution. This would get rid of numerous factors that are severely handicapping the industry, and for which a heavy penalty has been paid.

CHAPTER IV

BREEDS OF CATTLE, FOODS, AND DISEASES

IT should be one of the first considerations of the dairy farmer to see that he has the right breed of cows, and to treat individual animals to yield the highest profit. The thoughtful breeder will not invest his money in inferior cows, he will not rear for dairying purposes inferior calves, and he will aim at keeping up a good flow of milk to commend the best return for his skill and labour. The careless breeder seeks no standard as a guide, he may forget that a worthless cow will eat more than a valuable one, and in the selection of a bull he is not difficult to please. Success cannot possibly follow when attention to breeding and rearing of stock is a secondary consideration on the farm. In the treatment of our subject let us enumerate the points to be specially noted by the dairy farmer:—

1. A knowledge of the pedigree of the bull, *i.e.*, the qualities of his ancestors.

2. The attainments of the cows to be crossed with, whether for milk or flesh. If for milk, the register of milking will attest their suitability.

3. Feeding and rearing of the calves in order to build up a strong constitution.

4. Judicious feeding of the matured stock to maintain body and milk.

5. Period of crossing, with attention to season, feed, and price of produce.

6. Suitability of district for breed.

One part of the country may be profitable for the raising of heavy milking stock, while another part of poorer soil and exposed conditions would be adapted for a lighter and more hardy breed of milkers.

SELECTING DAIRY STOCK

The Bull.—Particularly in a dairy herd, the milking propensity is quite as transmissible through the male as through the female line. Whatever the breed, the first stage of improvement must begin with the male, and to this end it is essential that pure-bred sires be used. It is customary to find, where well-bred bulls have been used for a few years, the standard of a once inferior herd is made valuable, and it has been recorded on several occasions that when a bull calf of faulty pedigree is saved from a favourite cow and used in the herd the good strain reverts back to the original inferior state. No more interesting and profitable a branch deserves the attention of the farmer than the building up of his herd of milking cows, let the breed be what it may. It must be borne in mind that the progeny from a cross-bred bull are usually inferior to himself, and the progeny of a pure bull and an ordinary cow are sometimes superior to the high-bred sire, as the offspring generally partake of the purest and oldest blood. To prove the value of a sire, it has been known for a very inferior class of Welsh cows, crossed by a pure shorthorn bull, to produce a very respectable herd, free entirely from the black colour, and when a cross-bred bull was used in the improved herd, the black colour of the Welsh strain returned to the progeny. A good dam and granddam go a long way to establish quality in a bull. By recording the quantity and quality of milk yielded by cows, and crossing animals of superior quality with a well-bred bull, the value of the herd can be raised to a profitable and creditable strain.

Let us now consider what points should be looked for in selecting the cow. The buyer should first of all satisfy himself that the animal is healthy, and of suitable age and size. If recently calved, he should receive a guarantee that the after-birth has not been retained. Cows are frequently put into the market with retention of the after-birth, or placenta as it is sometimes called, and not a few farmers have suffered loss in consequence. Turning to the points of dairy cattle: first, face the cow, and look at her conformation; see if she is of the wedge-shape—a characteristic of all milking strains. Satisfied that her fore- and hind-quarters are not of the beef-producing type, glance at the neck, which should not be too short and thick; look at the withers, and notice the slope; if too fat and fleshy, suspect a beef strain; pay particular attention to the depth of the hind-quarters, as her future greatly depends upon this point; if shallow and tucked up, leave her alone, unless other points and price are tempting. Observe if there is abundance of space in the young cow betwixt the hind-legs for the development of the udder. Look for the escutcheon, which is the hair with the upward tendency seen on the buttocks, and which produces a kind of fringe at the line of juncture. Frequently in good milkers the escutcheon is prominent, and extends to the udder and partly over the legs. Take notice

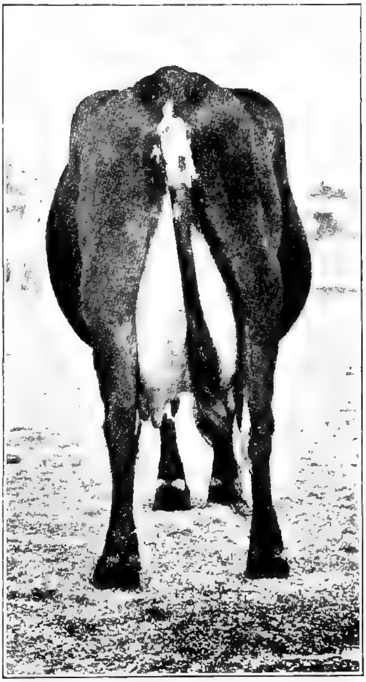


FIG. 24.—Back View of Cow showing Width of Quarters (Thomson).

of the size and shape of the udder and position of the teats, and look carefully at the milk veins. Veins of heavy milkers are as a rule large and often double, and appear on both sides, extending along the belly in the form of wavy lines. Examine the entrance of the veins and feel for indentations or holes. Fine, soft hair and skin on the udder are additional favourable points. Do not forget to ascertain if the cow has a good temper, as temperament has much to do with the milking qualities. A fair idea of this is generally obtained from the animal's appearance and movement when handled. One does not infer that all of these points are to be found in individual animals; but when a person is acquainted with such as a guide, it is easy to apply the points in the selection and judging of milking stock. And before a cow is bought the farmer should insist on having authentic proof of the cow's record for milk.

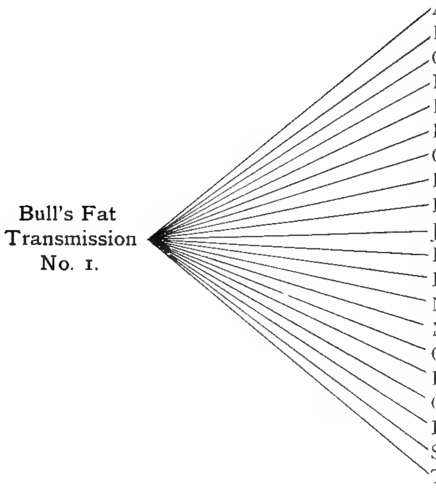
TRANSMISSION OF QUALITIES

It is not sufficient to select a dairy bull because he is a beautiful animal of his breed, or well nigh perfect from the show ring standpoint; that is judging on appearance, or what the eye can see, which is about one quarter of the value of the bull for dairying purposes. The beautiful bull with a showyard pedigree may have no milking pedigree, but he may have shapely progeny. A combination of appearance and milking qualities, particularly the latter, is desired, and the power of transmitting dairy qualities to his progeny with a degree of certainty is what the dairyman wants in a bull. It therefore follows that the practice of judging dairy stock is faulty as a direct contributor to high milking qualities in cattle, and the system can be harmful as practical farmers already know. A cow might be a great milker and a noted prize-winner but she might be a "sport" so to speak, and a bull might be famous in the dairy show ring, and uncertain as a transmitter of profit to the farmer, who depends on the milk supply for his success. As already inferred the influence of the average show ring is to educate breeders of dairy cattle to model their stock, and the awards as at present judged should, educationally and commercially speaking, be given solely on that basis, in fact the card should read "Judged on appearance." On the other hand where the milking pedigree is taken into consideration from authentic records, the decision might be divided between appearance and milking pedigree or solely on the latter.

One can arrive at the value of a dairy bull by his power of transmitting fixed inherited qualities to his progeny. For this purpose it is necessary to know his milking pedigree, which really is his ancestral value. This will more easily be obtained now that a universal system of milk testing is being enforced, and the subject of the milking pedigrees of bulls should appeal very strongly in all counties in Britain and in the Colonies where official registers of dairy stock are to be kept.

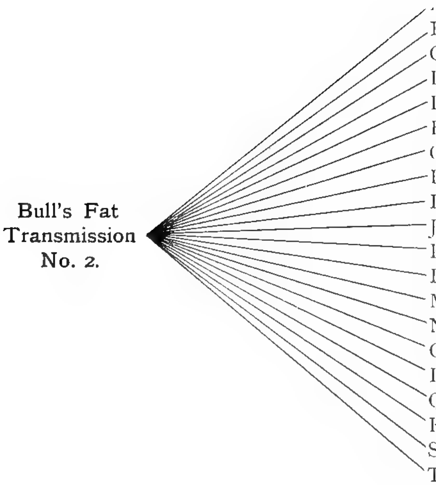
It is understood that the bull transmits fat-producing qualities to milk, which he derives from his mother and maternal ancestors, and his power of transmission can be ascertained by determining the yield and fat percentage of milk given by his female progeny at a certain age, and comparing this with the average of the mother's progeny at a similar age. This should be quite apparent to the average reader, and Swedish investigators, who are very advanced in this department of research, add that the influence of the female in the transmission of fat is shown by the fact that a bull can only raise the average fat aggregate in the progeny of cows giving a lower fat percentage than himself (the figure representing his power of transmission), and the fat yield will become less than the mother's if the same bull is mated with cows that give a higher fat percentage than the bull. The bull can, therefore, raise the average fat percentage of a strain of cows giving poor milk, whilst he has a lowering effect on

MOTHERS OF FEMALE PROGENY, 5 YEARS OLD.



	Average Fat Test, 1914.	Average Milk Yield, 1914.
A.	3.7	600
B.	3.6	650
C.	3.8	630
D.	3.7	600
E.	3.9	620
F.	3.7	650
G.	3.8	620
H.	3.6	700
I.	4.1	680
J.	4.0	670
K.	3.8	690
L.	3.6	730
M.	3.4	800
N.	3.5	780
O.	3.8	680
P.	3.6	700
Q.	3.5	670
R.	3.9	660
S.	4.0	640
T.	3.9	600

FEMALE PROGENY, 5 YEARS OLD.



	Average Fat Test, 1914.	Average Milk Yield, 1914.
A.	4.0	620
B.	4.1	670
C.	4.2	650
D.	3.9	610
E.	4.0	640
F.	3.8	660
G.	3.9	680
H.	3.7	730
I.	3.9	700
J.	4.2	690
K.	4.0	700
L.	3.9	750
M.	3.7	820
N.	3.8	800
O.	4.0	700
P.	3.8	700
Q.	3.7	710
R.	4.0	680
S.	4.1	650
T.	4.2	620

cows with a high aggregate fat percentage. The bull's fat-transmitting power could readily be fixed, as illustrated in the opposite page.

The same investigators say that the male and female exercise a like influence on the fat if both present an equal constancy in their percentage, but the male owing to his more numerous progeny exercises the greatest effect. In the transmission of fat-producing qualities to individual animals there will be a want of uniformity compared with the parents, but the average for all descendants should compare with the average of the father and mother. In improving animals the maximum useful value should be aimed at, and an abnormally high milk yield and fat yield should not be the object of the breeder. A high yield at the expense of fat or *vice versa* is not recommended. The best way to obtain high fat percentages in milk is to exercise a strict selection of bulls, being guided as suggested.

BREEDS

Preceded by the following tables we shall give a short account of British and foreign breeds of cattle preferred for dairying purposes.

Dairy Breeds in Britain

Suggested Averages for the Whole Country

Breed.	Distinctive Colours.	Average Weight.	Average Yield of Milk per Annum.	Average Quality of Milk.	Average Commercial Price.
		Lb.	Gals.	Fat. Per Cent.	£
Dairy shorthorn	Red, red and white, and roan	1,350	600	3·5	20
Ayrshire	Red and white	1,050	500	3·6	18
Jersey	Golden fawn	830	400	3·9	20
Guernsey	Orange and white	1,000	500	3·9	21
Holstein	Black and white	1,300	700	3·2	22
Kerry	Black	800	350	3·7	14
Devon	Red	1,100	450	3·6	18
Welsh	Black	950	350	3·7	15

COLONIES

Country.	Predominating Breeds.	Distinctive Colours.	Average Weight	Average Yield of Milk per Annum.	Average Quality of Milk.	Average Price.
			Lb.	Gals.	Fat.	£
New Zealand	Ayrshire, Jersey, and Crosses	...	...	480	3.6	12
Australia	Shorthorn, Ayrshire, and Crosses	...	...	300	3.5	9
Canada	...	...	...	450	3.6	14
Africa	...	...	...	290	3.7	17
		FOREIGN				
Italy	Simental	Red and white	1,150	620	3.7	30 to 35
Switzerland	Simental	Do.	1,200	630	3.7	25
Germany	In South Germany, Simental. In North Germany Schwarzbuntes Vieh	Do.	1,150	620	3.7	25 to 30
Belgium	Friesian	Black and white, red	1,100	700	3.2	22
Holland	Friesian	Do.	1,100	700	3.2	22
Denmark	Red Danish, black and white Danish	...	1,100	600	3.4	23
Sweden	Native	Red and white	1,400	680	3.6	27
Russia	Native	Fawn and grey	950	280	3.8	6
Roumania and the Balkans	Native	Do.	900	270	3.8	7

In France there is a number of excellent dairy breeds, and in accordance with French averages they may be classed as follows:—

Breed.	Colour.	Weight.	Milk Yield.	Fat Percentage.
		Lb.	Gals.	
Normandy	Red and white	1,230	800	3.0
Flemish	Red and spotted	1,160	750	3.6
Friesian	Black and white	1,220	740	3.3
Simental	Red and white	1,050	600	3.8

The average price of French cows is between £25 and £35. The Parthaney of France is reputed to give the richest milk of any breed in the world; 16 and 17 lb. of milk to 1 lb. of butter are not uncommon factory averages for the year.

Italy.—Many of the Simental cattle in Italy are bred in the Alps, especially in the valleys near Bergamot. High-class breeding cows of the second and third calf, and with marked milking qualities, may average £40 per head. The cows are almost exclusively fed on the Lombardy clover, which is indigenous to the Lombardy soils, where it grows without cultivation. The giant Dutch clover that is sold in Britain is said to be of the same variety.

Belgium.—Dutch cattle are numerous, and the chief native breeds are the Tirlemontoise and Veurne-Ambacht.

Denmark and Sweden.—Besides the native breeds there are many imported herds of Ayrshire and Friesian cattle, and in Sweden the native cattle show proof of the early crossing with the Shorthorn.

Austria.—The leading milk breeds in Austria are the grey-brown Alpine cattle of the Tyrol and the Montafoner, Oberinntaler, Sechtaler, Etschtaler.

The Pinzganer predominates in the Eastern Alpine provinces, and in Moravia and parts of Bohemia the Kuhländer and red-spotted Moravian cattle, are prized for milk and beef.

Simental and Dutch cattle have been used extensively to cross with native cattle in Bohemia, Upper Austria, Eastern Tyrol, and Galicia.

The following is the average live weight, milk yield, and fat content of the chief Austrian breeds:—

Breed.	Live Weight.	Average Yield of Milk.	Fat Content.
		Gals.	Per Cent.
Montafoner	1,040	620	2.7
Oberinntaler	800	480	3.8
Pinzgauer	1,100	440	3.7
Marialiofer-Lavantaler	1,000	430	3.7
Murbodner	1,040	400	4.0
Kuhländer	1,000	440	3.6

In Hungary the Simental is a favourite, and numerous crosses of this famous breed, also the Schwyz and Friburg, with the native cattle may be seen in many districts. The Swiss cross is vastly superior to the native animal for milk and beef, and for draught purposes it meets the demands of the peasant.

Germany.—Breeds may be divided into (*a*) the North German lowland cattle, and (*b*) the cattle of South and Central Germany.

(*a*) Included are the black and white, and red and white lowland breeds, red and white Holstein; Angeln and Shorthorn.

(*b*) Large light coloured and large grey-brown mountain breeds; Penzgau; the red cattle; Glau-Donnersburg and yellow Frankin cattle. For draught purposes the red cattle of Central Germany are extensively used in districts where the land is in the hands of small farmers. Both the bullocks and cows take an active part in farm operations. The breed is being improved by importations of stud cattle from Simental, but perhaps the greatest effort to raise the milking qualities of German cows is being shown in Bavaria and Allgau. There the draught oxen are not so much in evidence. The nose, tongue, and mouth of an Allgau cow are dark blue; there is a white rim on the muzzle, rings are seen round the eyes, horns are black tipped, and the breed is comparatively small and fine in appearance, as shown in the illustration.

GERMAN BREEDS

Breed.	Colour.	Live Weight.	Yield of Milk.	Fat Percentage.	Price.
		Lb.	Gals.		£
Lowland cattle	Black and white -	1,300	800	3.1	20
,,	Red and white -	1,250	850	3.3	23
Holstein	Red and white, and black and white	1,300	750	3.3	23
Shorthorn	...	1,300	550	3.6	30
Allgau	Grey-brown, fawn	800	600	3.7	20
Angeln	Light red -	820	450	3.2	13

Siberia.—Along the railway route in Western Siberia cows cost £6 on an average. Lower grades can be bought from £3. 10s. to £3. 15s., and good cows for £7. Further off the railway the cheaper they become, and near the Chinese frontiers cows may be purchased for 50s. Huge profits are made by dealers who go to these parts and purchase large herds for sale in the dairying districts along the steppes. The cattle are driven distances ranging from 1,000 to 1,500 miles. They feed *en route*, and with favourable weather many show an improved condition on their arrival.

Canada, New Zealand, and Australia.—British breeds in these Dominions are principally kept. In 1911, dairy cows in New Zealand numbered 633,733.

In Africa imported cattle are taking the place of the native stock.

United States of America.—There are five prominent breeds in this country; the Jersey probably predominates, with the Friesian-Holstein, Guernsey, Ayrshire, and brown Swiss ranking in the order named. The number of cows in the United States is reported to exceed 20,000,000, and the average yield of milk per cow is given as 500 gals. Improving milking breeds is now being actively pursued, and the following is a summary of the advanced Registry

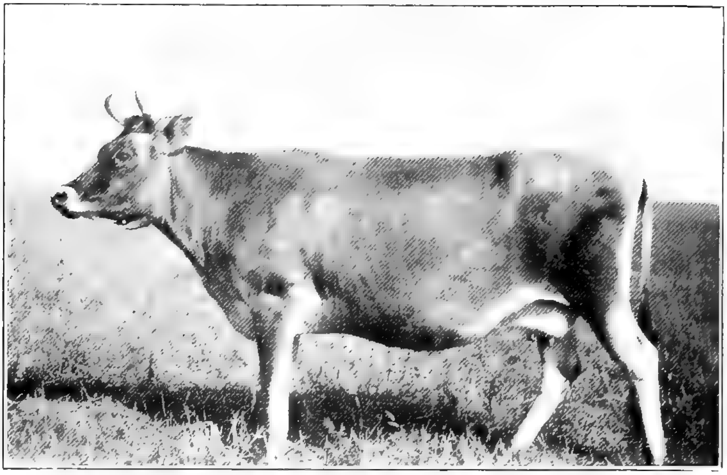


Fig. 25. Pure Bred Jersey Heifer (Thomson).

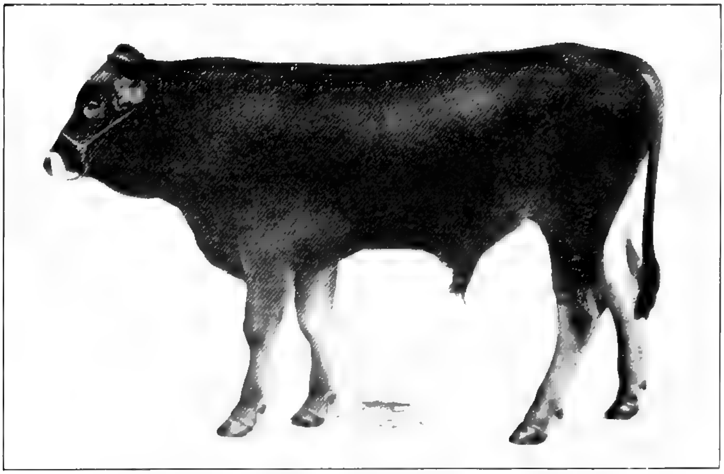


Fig. 26. Young Allgau Bull (Germany, Vine. Soyer).

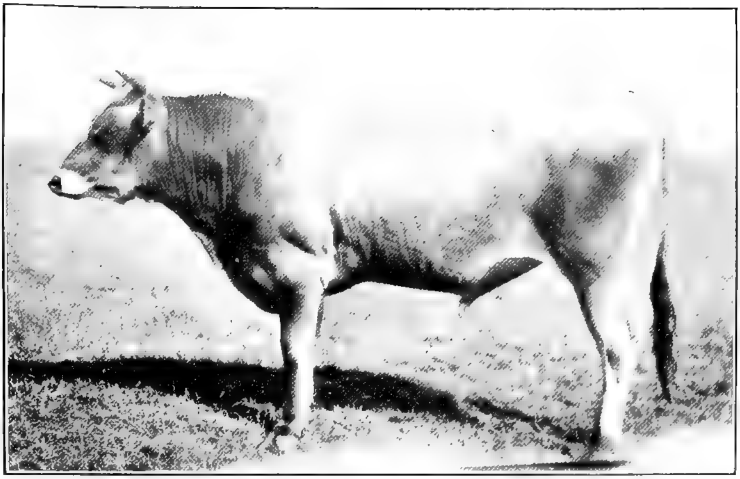
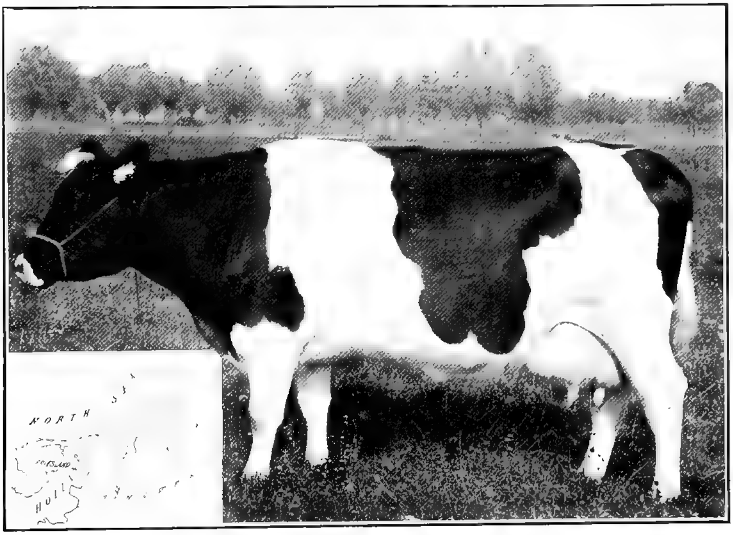


FIG. 27. Young Balkan Bull (Thomson).



Department of Agriculture, The Hague.

FIG. 28.—Friesian Cow, "Nellie II."

In 300 days this cow gave 12,244 lb. of milk, which contained an average of 3.52 per cent. butter fat. The abridged map by the author shows the situation of Friesland in the Netherlands, and Holstein in Germany.

records as supplied by the United States Department of Agriculture :—

Breeds.	Milk Yield.	Fat Content.
	Gals.	Lb.
Jersey	746	407
Holstein	1,400	494
Guernsey	800	414
Ayrshire	893	359
Brown Swiss	1,060	429

These averages are much higher than those obtained in Britain, and if we consider what has been accomplished in Sweden, Denmark, and Canada further proof will be obtained of breeds breaking the records of the countries from which they were imported. Swedes claim to have excelled the Danes in this direction, and they attribute their success to an advanced system of milk testing.

Numbers of the small cows of Siberia and the Balkans, also the Allgau and Angeln breeds of Germany, the Schwyz and the Parthaney of France, resemble the Jersey. In the Balkans no evidence could be obtained of any relationship beyond that in the early history of railway construction British contractors had a few Jersey cows brought to the Balkans from the Channel Islands to supply milk to their staff. A thoroughbred Jersey calf and the average Roumanian calf are very similar in colour and points—in fact one would readily be mistaken for the other. The head of the Balkan calf is small, the eye dark, there is a distinct rim round the muzzle, and the animal has a deer-like appearance. As the calf gets older the colour changes to a blue-grey, and a distinguishing feature is the short neck and loose skin under the throat. Some "pure bred" native cows and bulls retain the Jersey characteristics in a very pronounced way, while the majority lose them through indiscriminate crossing.

The Netherlands.—The chief breeding centre of the famous Friesian cattle is in the Province of Friesland in the north-west of the Netherlands. The soil is a clay, and practically under permanent pasture. Climate is somewhat moist with a rainfall which averages about 30 inches. The Friesian is a lowland breed, and is adapted more to flat country and a cool climate. Strict attention is now being given by native breeders to raise the fat standard of the milk, as it is recognised that the chief criticism or objection to Friesian cattle has been the low percentage of fat compared with other high class dairy breeds. Their efforts are meeting with success, and it will only be a matter of a few years when the average will be distinctly higher. In Sweden with the most thorough and advanced system of milk records in the world, this has already been accomplished with the Friesian cattle, and the same may be said of other countries where the breed is established. The demand for the breed is increasing, and a good export trade is done with the South of Sweden, Germany, Belgium, France, and Spain, also with South Africa, and of recent years New Zealand and Japan are promising patrons.

The Friesian cattle may be divided into two classes, which are chiefly distinguished by their colour, one being black and white, and the other red and white. In the Friesian Herd Book of the Netherlands the two classes are recorded in separate chapters, and cattle of mixed colours are not registered. The black and white cattle are more sought after, and accordingly native breeders have concentrated their attention to the improvement of this class. In the United States the breed is called Holstein-Friesian, thereby embracing the two provinces chiefly associated with "black and white" breeds of cattle. One hears of the name "Dutch," also Holstein, being applied to the Friesian breed, but this is misleading. There are different classes of Dutch cattle, namely, the Oldenburgers, Groningen, and Beemster, which are supposed to be descendants of the same parent stock; also the Flanders cattle of Belgium and France, the Brittenburg of Germany, and the Kholmogorski breed of Russia are said to be offshoots of the early Holstein race.

The Dutch Belted cattle (Lakenvelders), called after the white band which encircles the body, are natives of Holland. They are also of a black and white colour, and numbers have been exported to America where the breed is registered. The Belted cattle are heavy milkers, and resemble the Friesian breed, although smaller.

In Switzerland the black and white Friburg breed compares with the Friesian in some respects, although the cattle are larger and heavier. It is quite possible that a relationship exists between the two breeds.

In Britain there is an association called "The British-Holstein Cattle Society." The recognised colours of British-Holstein cattle are black, black and white, dun, dun and white, and animals of these colours are eligible for entry in the Society's Herd Book. Some splendid results have been obtained with the breed, but the absence of Friesian blood from the Netherlands must necessarily handicap the Society's efforts.

Switzerland.—The chief Swiss breeds in order of importance are: Simental, Schwyz, and Friburg. They have what one might call the triple qualifications—milk, flesh, and work. A good yield of milk is given by each breed. The quality averages not less than 3.5 per cent. The flesh of the Simental, Schwyz, and Friburg is excellent, and the three breeds are eminently adapted for farm labour.

In Switzerland about 70 per cent. of the soil that is devoted to agriculture is pasture land, and the open air life for cattle is followed very profitably by Swiss breeders. Constitution claims wrapt consideration, and the wonderful power of transmission possessed by the Simental breed is partly attributed to this condition.

As the cultivation of grain is decreasing in Switzerland, farmers are giving closer attention to the milking qualities of their herds, and less to developing the cattle for farm labour. The breeds are being better modelled, and the coarse rump and tail, so common amongst Swiss cattle, is disappearing. Coarseness was attributed to farm work and to the influence of hill climbing. The writer has observed this peculiarity in a very pronounced form amongst cows in the hilly districts around Adelaide, South Australia, and in other parts of the world It will be observed from the illustration that the Schwyz breed is not unlike the Jersey; in fact there is a strong resemblance both in colour and other points. The summer food of these breeds consists exclusively of meadow grass, and the winter rations are made up of hay, crushed maize, and crushea beans; beetroot and dried brewers' grains are also used. It will be readily understood that the milk of Swiss cattle possesses high keeping properties, hence its great value for the manufacture of condensed milk.

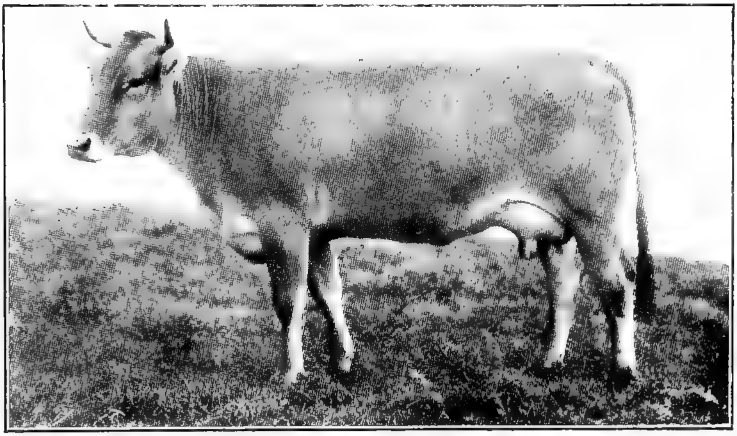


FIG. 29. Schwyz Cow.

There are over 500 cattle breeding associations in Switzerland, and when a Herd Book is kept the association is assisted by a subsidy granted by a confederation.

Low Milk Averages.—The lowest averages recorded by prominent countries may be taken in the following order: -

Country.	Annual Yield in Gals.
Siberia	280
Africa	290
Australia	300
Ireland	450

The cause of the low milk records in Australia and Africa is attributed to the absence of care in the selection of suitable bulls, and to a general weediness amongst the cows. In Australia there is too high a percentage of scrub cattle amongst dairy herds, and the distinction between the milk and beef breeds is not sufficiently marked. The same applies to Africa. Further, the practice of allowing the calves to run with their mothers for a time is injurious to the milk yield and to the cows for dairying purposes. Closer settlement, and the free use of the Babcock tester and balance, will contribute to a quick improvement in the standard of cows in Australia and Africa. But the question of meeting the demand for good stud cattle will have to be faced by both countries, and there is no better way of doing it than by establishing breeding farms under the guidance of the State.

In Hungary a stud farm of fully 40,000 acres is owned by the Government, and the value of the estate is between £2,000,000 and £3,000,000. The farm was originally established to breed remounts for the army, and those who know the Hungarian horses can understand how well the object of the Government has been accomplished. Stud cattle are now receiving close attention, and at present there are on the estate some 2,000 head of the Siementhal breed, of which 1,000 are breeding cows. The bulls and cows are sold at ordinary prices for distribution throughout Hungary to improve the milk and beef qualities of herds. But the work is not confined to breeding; other branches of agriculture are taken up, such as dairying, beet and hemp cultivation, and there are modern factories on the estate to handle the produce grown. Nine thousand five hundred people are residing on the "farm," principally as employees.

Indian Breeds.—The following lines on Indian breeds have been kindly supplied by Mr G. H. Frost, a dairy expert in the service of the Indian Government.

Bhagnari Cattle.—This is a particularly large boned animal, weight about 700 lb.: in good condition very similar in appearance to the large breeds of Hansi cattle. The larger class measures about 56 inches to the shoulder, white or fawn in colour, with horns growing upwards and inwards. They are carefully kept by the Baluchi breeders in Southern Baluchistan. The bulls are very much sought after for siege train purposes, and municipalities and others also import them from Sibi Fair. The cows are poor milkers on account of breeders aiming at a perfect draught animal. The average yield is about 10 lb. a day and 1,500 lb. per period of lactation.

The cost of a good bull would be about Rs. 100, the cow about 130.

The cattle are only found in the districts between Sibi and Jacobabad.

They are seldom affected by Rinderpest, but when an attack does appear it is very severe, and they are treated as hill cattle for Serum.

The Afghan or Kandahari Cattle.—These are the nearest in shape to English cattle that I have seen; they are usually black with glossy hair, long and square in the quarters. The Amir of Afghanistan has forbidden the exportation of these animals from his kingdom, so they cannot now be obtained in Baluchistan. Their live weight is about 650 lb.

The cows are the best milkers I have met outside

England, the two we had on this farm giving as much as 40 lb. a day. They are particularly suited to the cold districts of Central Asia. It is understood that Kandahar is the centre of this breed. These cattle are very difficult to pull through an attack of Rinderpest.

Shorthorn.—The Shorthorn is divided into two classes, the Booths and the Bates.

The Booths represent the fattening strain, being more fleshy, thicker, shorter legged, but less stylish and more patchy. The Bates represent the milking strain; they are more upstanding, gay, and handsome, with clean-cut head and fine carriage, but narrower, thinner in flesh, and less suitable for the butcher.

The distinctive points of the Shorthorn are as follows: The colour of the skin should be creamy yellow all over, without any black points either in the mouth, nose, ears, eyelids, or horns; the hair should be red, white, or roan, but not brindle or black; the horns should be wide set, not turned up at the points, curving, and rather flattish.

The good qualities of the Shorthorn are their rapid growth, quick fattening, early maturity, and large size. The dairy strain are splendid milkers, quiet and good-tempered, fairly hardy, and adapt themselves to a considerable variety of food and climate. They possess a combination of good qualities not excelled by any other breed. Their great value depends chiefly on the remarkable certainty with which the bulls impress their good qualities on their progeny out of inferior breeds with which they have been crossed; their crosses with coarse animals are more symmetrical, with small cattle are larger, with slow feeders are quicker, and the progeny retain in a striking way any good qualities they may derive from their dams. The milking Shorthorn is specially suited for warm and dry districts where food is plentiful. They are much less suitable than the Ayrshire for bare, hilly,

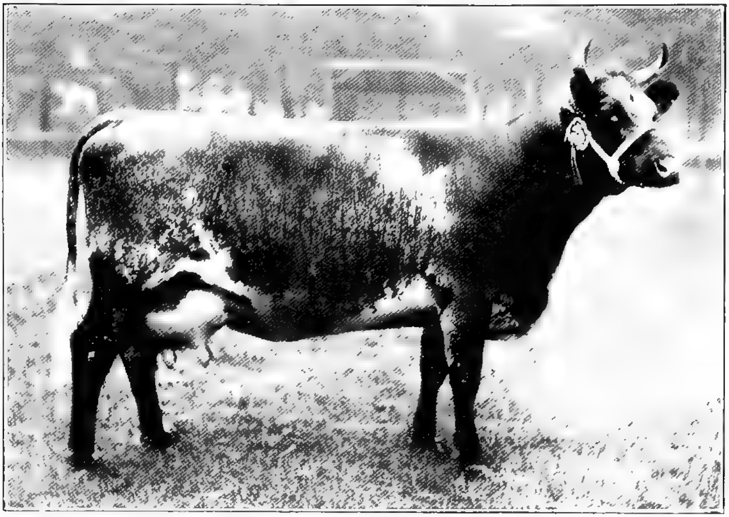


FIG. 30.—Hawthorn VII.

Bred by R. W. Hobbs. She gave 10,802½ lb. of milk from March 31st, 1911, to Feb. 24th, 1912. Hawthorn was purchased from her breeder by Lord Derby for 160 guineas.

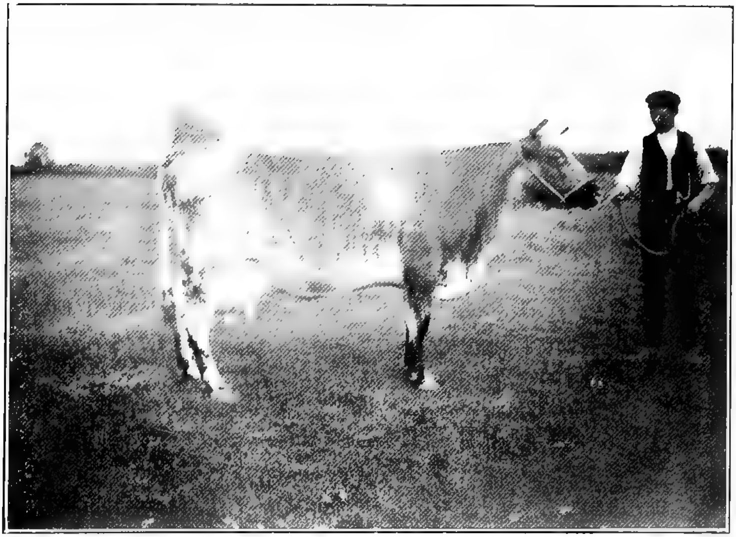


FIG. 31. Primrose 70th.

Bred by R. W. Hobbs. Her milk yield from April 1st, 1908, to March 8th, 1909, was 13,783 lb.

and poor country, owing to their greater size and more tender constitution.

In the purchase of a Shorthorn bull for dairy purposes, one must be confident that the animal belongs to the dairy strain. Many a good Shorthorn bull has been condemned owing to the low milking standard of his stock, but in all probability the mistake lay with the purchaser in choosing a bull from the wrong strain.

Ayrshire.—The Ayrshire is universally allowed to be in its form the true type of a dairy cow. The special characteristic point in the breed is the wedge-shaped body, *i.e.*, the narrowness in front, and its gradual widening and deepening backwards. This peculiarity is visible either from front, above, or broadside. She is hardy, and yields from inferior food a large quantity of milk. The Ayrshire is honoured in many countries, and thrives in all climates. She is capable of great attainments as a milker. Her milk is of good quality, and is specially suitable for cheese-making, as the butter particles are small, and mix better with the curd to make a rich and uniform cheese.

It will be of interest to relate the points of the Ayrshire, so that readers may readily observe the features of importance when inspecting this breed of cattle. These are taken from the published reports of breeding associations: —

1. Head short, forehead wide, nose fine between the muzzle and eyes, muzzle large, eyes full and lively, horns wide set, small, and inclining upwards.

2. Neck moderately long and straight from the head to the top of the shoulder, free from loose skin on the underside, fine at its junction with the head, and enlarging symmetrically towards the shoulder.

3. Fore-quarters — Shoulders sloping, withers fine, chest sufficiently broad and deep to ensure constitution, brisket and whole fore-quarters light, the cow gradually increasing in depth and width backward.

4. Back should be short and straight, and the spine well

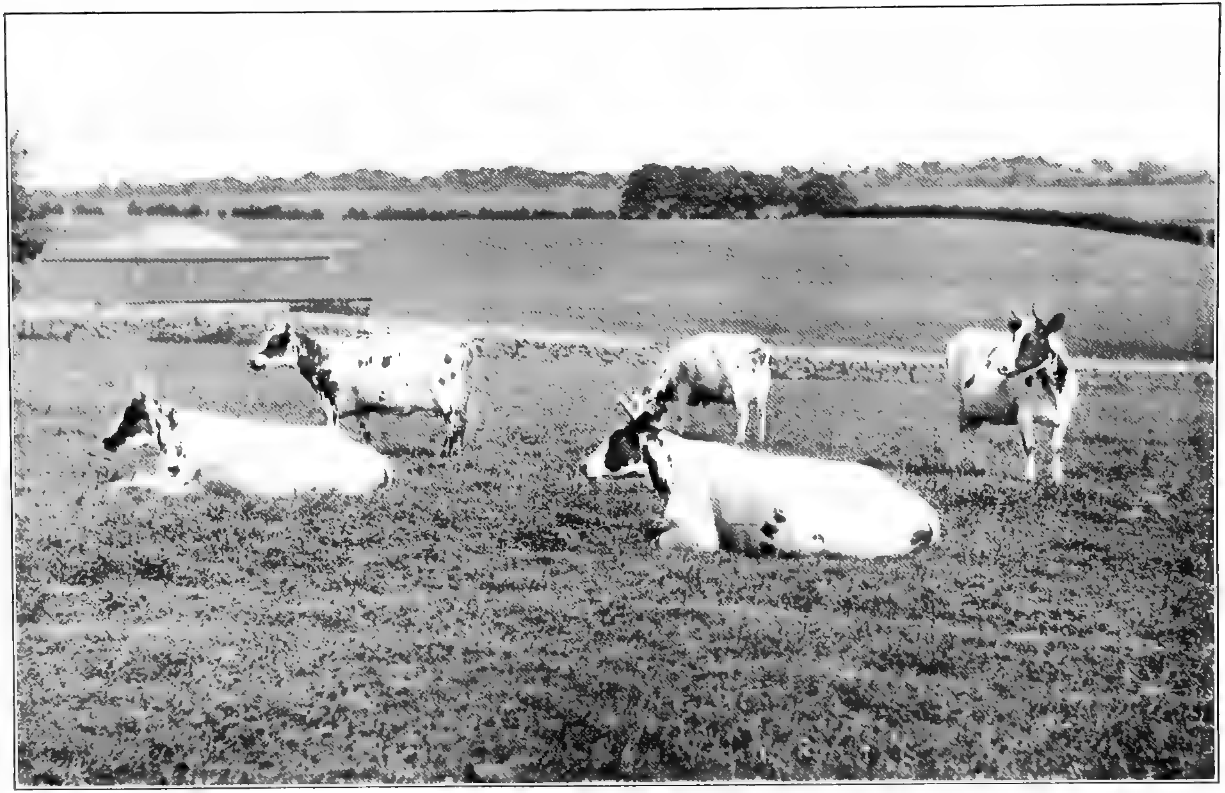


FIG. 32. Group of Pedigreed Ayrshire Cows at the Farm of the Breeder, Adam Montgomery, Lessnessock, Ayrshire.

defined, especially at the shoulders; ribs short and arched, body deep at the flanks (important).

5. The hind-quarters long, broad and straight, hook-bones wide apart, and not overlaid with fat, thighs deep and broad, tail long, slender, and set on level with the back.

6. Udder capacious and not fleshy, hind part broad and rounded like the side of a cheese, the whole firmly attached to the body, the sole nearly level and extending well forward; milk veins well developed; teats from 3 in. to 3½ in. long and hanging perpendicularly, distant apart at the sides equal to one-third of the length of the vessel, and across to about one-half of the breadth.

7. The legs short in proportion to size, bones fine, and the joints firm.

8. The skin soft and elastic, and covered with soft, close, woolly hair.

9. The colour red of any shade, brown or white, or a mixture of these, each colour being distinctly defined; brindle or black and white are not in favour.

Shorthorn-Ayrshire Cross.—The cross from an Ayrshire cow and dairy Shorthorn bull produces a valuable milker, with a good fattening quality. Their splendid dairy records are to be found in many countries. As an illustration, the following may be taken: Upon a farm of 20 acres in Victoria, Australia, eight dairy Shorthorn-Ayrshire crosses gave in one year an average of 778½ gals. of milk, with a butter fat test of 3.7, making on an average 333 lb. of butter. Care in selection and feeding brought the standard of this herd to its valuable and profitable position. It is recognised that no better cross for combined dairy and fattening purposes is known to the dairy world.

Jersey.—The Jersey is a beautiful breed of cattle, slender and graceful in form, with a refined, deer-like appearance, small head and distinct muzzle, expressive eyes, slender tail, thin, deep yellow skin, and very clean in the bone. The horns are short, smooth, crumpled, and tapering, with black tips. Colour of skin is said to indicate richness of milk. Compared with the Guernsey, the most noticeable features are smaller size, a more thoroughbred-like appearance, horns thinner, face finer and more docile and intelligent looking, the eye is bright black, often with a white rim, tongue black, and the muzzle black, with a light coloured rim round it. This is one of the most

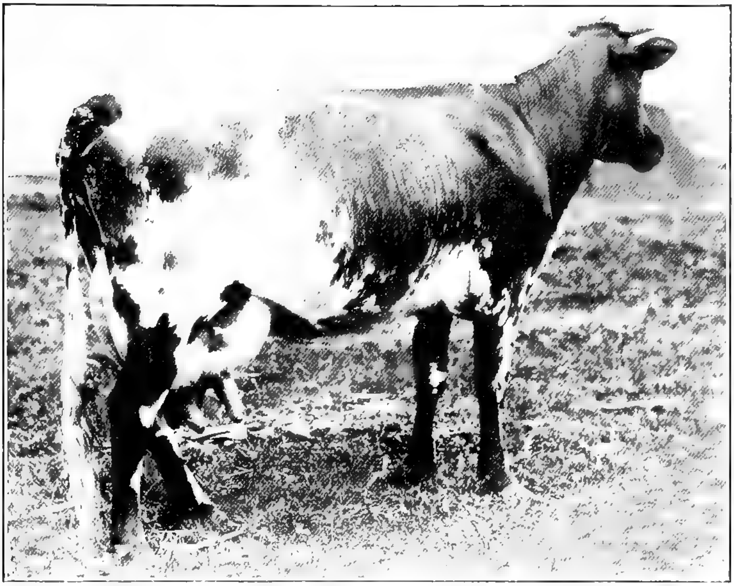


FIG. 33. South Coast Dairy Cow.

This class of dairy cow has established a great reputation in New South Wales. It is a cross between the Shorthorn and Ayrshire, and takes its name from the district where the "breed" predominates. The cows are heavy milkers, and are in good demand in Queensland and other parts of Australia.

striking differences between the Jersey and Guernsey, and a distinctive feature of the former. The qualities of the Jersey as a butter-making cow has no rival, although closely followed by the Guernsey. As will be observed in a foregoing table, her quantity of milk is not very high, but is rich in butter fat, which occurs in large globules, and makes butter of a beautiful golden colour. The butter is easily worked, and wax-like in appearance. Many Jerseys give over 350 lb. of butter in the season, but they have little or no value except for milking. As a rule, the cows are gentle and docile in disposition, but are unsuited for barren districts. It might be observed that milk from freshly calved Jersey cows retains the strong colostrum flavour longer than the milk from heavier breeds, and when the cows graze on weedy pastures the milk would appear to hold the plant taints in a somewhat fixed condition.

Jersey-Shorthorn Cross.—This is an exceptionally attractive cross. Using the Jersey bull with the Shorthorn cow good results are usually obtained. In some parts of South Australia the above cross predominates, and the writer had once occasion to make an inquiry into the merits of the Jersey-Shorthorn for dairying purposes, with the result that the cross gained in popularity to the benefit of the industry throughout the State. Crossing extreme types of cattle is certainly not to be recommended; it is better to keep the breeds pure, but there are often conditions and circumstances at work which prevent farmers from keeping herds of well-bred stock.

Erroneous Ideas of Jersey Breed. -One generally hears of the Jersey cow as a tender, delicate animal, best suited to grace the pleasure park, or the dairy farm of the wealthy country squire. This is not the case, as the writer can prove, having had some years' experience of the breed in Eastern Europe, where the extremes of heat and cold are features of the summer and winter climate. The Jersey will withstand these conditions in a way that would please her admirers, and astonish her critics. It is not the heat or the cold that tells on the Jersey cow, it is the wet and damp weather; and if owners would take steps to prevent injury from this cause, fewer cases of ailment amongst Jersey cattle would be found. The leanness of many Jerseys favours the lodgment of rain in the cavities of the back. There the water remains under ordinary conditions, and through this cause many an animal contracts a fatal disease. This warning is given as the outcome of observation of the breed in three different climates. In Siberia the Jersey will thrive to perfection, because the dryness of both seasons is conducive to her health, and all that is required in the winter months is protection against the severe cold. Vigorous Jersey calves have been reared in cow-houses that frequently fell below freezing point.

Guernsey. -A number of years back all Channel Island cattle bore the name of Alderney, an island that supplies a very small number of these cattle, and whose breed, by the use of Guernsey bulls, have become larger and coarser than the fine, deer-like Jersey. In late years the difference between the Guernsey and Jersey has become more marked, both in size and colour, and particularly the head, horns, and nose. The Guernseys are generally of a yellow-brown colour, patched with white on legs, belly, tail, rump, shoulder, and head. They are sometimes spoken of as "orange and lemon" cattle. In weight the Guernsey is by no ways mean. She is of the desired wedge-shape, high and broad in the hind-quarters, narrowing towards the front, yet she is not thin in the chest like many milk cows, but has a thickness through the heart which indicates constitution ; her skin is of a rich yellow, and the colour of her milk and butter is even higher than that of the Jersey. In size the Guernsey is nearly a third larger, and she is more robust. The following show scale will serve to indicate the main characteristics of the breed, and the award of points is worthy of attention :—

1. Head fine and long, muzzle expanded, eyes large, quiet and gentle expression	4
2. Horns yellow at base, curved, not coarse	3
3. Nose free from black markings	1
4. Throat clean, neck thin and rather long, and heavy at shoulders -	7

5. Back level to setting on of tail, broad and level across loin and hips, rump long	10
6. Withers thin, thighs long and thin	4
7. Barrel long, well hooped, and deep at flank	10
8. Tail fine, reaching hocks, good switch	1
9. Legs short, arms full, fine below knee and hocks	2
10. Hide mellow, and flexible to the touch, well and closely covered with fine hair, yellow inside the ears, at the end of tail, and on skin generally	12
11. Fore-udder large and extending forwards and not fleshy, udder full in form and well up behind, with flat sole, teats rather large, wide apart, and squarely placed	25
12. Milk veins prominent, long, and tortuous	6
13. Escutcheon wide on thighs, high and broad, with thigh ovals	5
14. Size, general appearance, and apparent condition	10

Holstein.—The Holstein breed is gaining in popularity in Britain on account of their large yield of milk, which meets with the wishes of that class of farmers who depend upon the city trade for success. The Holstein and the Friesian are unsurpassed for this purpose, but it is questionable if they are at home in warm climates. The writer has observed in a hot, dry country that the Holstein appeared to lose its attractive shape, becoming coarser in frame and less symmetrical. For the Holstein and Friesian cattle there should be a good future in Britain, Canada, New Zealand, and in the cooler parts of Australia and South Africa.

The *Kerry* is the only pure native Irish breed of cattle. There are two classes, the true Kerry and the Dexter Kerry. The true Kerry is a neat, active, and very symmetrical little animal, with a fine compact head and white cocked horns tipped with black. Black is the fashionable colour, but there are black and white and also red Kerries. The Dexter is the result of a cross introduced over eighty years ago by a Mr Dexter, and is a heavier, coarser, and thicker boned and less symmetrical animal, with horns inclined to be longer and straighter. The true Kerry is very hardy, fattens readily, and yields a fine quality of beef. Cows give very rich milk, and a large quantity for their size. The breed is adapted to hilly and rough country.

Devon.—The Devon breed is divided into two classes, the North and the South Devon. The latter is more suited for milk and flesh, and in their native county, and in the Midlands, the cows are very popular with dairy farmers. A useful export trade is done with Devon cattle, particularly to South Africa, also a good many animals have been shipped to the Argentine and the United States. In some parts of South Africa where the dairying industry is coming into prominence, the Devon cow predominates, and she is esteemed for her general hardiness, good milking qualities, and her aptitude to fatten. As a dairy cow, the Devon could be further improved.

Welsh.—Like the above breed, the Welsh cattle are also of two classes—the South Wales and the North Wales black cattle. The former are very useful for dairying purposes, and are of excellent constitution. The North Wales are more adapted for fattening, and the meat is of excellent quality. The South Wales cattle and the West Highland have a resemblance. With the Kerry, they may be classed as the hardiest breeds in Britain, and they enjoy a wonderful immunity from tuberculosis for apparent reasons.

Summing up the breeds we may regard the Shorthorn as the most suitable for dual purposes—milk and beef—followed by the Devon and Shorthorn-Ayrshire. For cheese-making the Ayrshire takes first honours. Butter-making—(*a*) Jersey, (*b*) Guernsey, (*c*) Jersey-Shorthorn cross. Town dairying or milk selling—(*a*) Holstein, (*b*) milking Shorthorn, (*c*) Shorthorn-Ayrshire. Cottagers—(*a*) Kerry, (*b*) Ayrshire, (*c*) South Wales cattle. Private families—Jersey.

The Importance of Nerve and Digestion.—A cow giving a large quantity of rich milk is expected to eat largely, and to digest and assimilate the food well. With vigorous digestion and strong nerve energy the cow will be provided with two necessary adjuncts in the formation of a large supply of milk. It is, therefore, of the utmost importance to pay strict attention to these factors. When the nerve temperament of a cow is disturbed, what is the result? Quantity and quality of milk is reduced.

When the average cow is roughly milked and harshly spoken to during milking, there is an immediate decrease in both quantity and quality of milk, and when this treatment is persisted in, permanent injury to the milking qualities of the cow is caused. The same takes place when cows are chased and disturbed by dogs.

A cow receiving a rich ration is expected to yield a high standard of milk. If the food is disliked by the cow, although partaken of, the flow of milk becomes affected. By changing the ration to one of poorer quality but relished by the cow, both the yield and the fat content of the milk may be increased. By exposure to cold, or damp weather, the flow of milk invariably drops, no doubt partly caused by the extra consumption of food required to supplant the additional loss of heat.

In the transmission of cows by rail or road, say, to a showyard, we find that the milk yield and fat percentage frequently fall below the cow's average. Again when a cow is suckling a couple of calves, and if the calves are removed when she is in full milk, the cow may not yield sufficient to nourish one calf. Changing from one pasture to another will influence the quantity and quality of milk to a surprising degree. The question may be asked, What does all this mean? It is the response of the milk glands, and if they are under the control of the nerves, consequently the milk-making machinery will influence the yield and quality of the milk. It is common for a cow to keep up her milk during milking, and we hear of the sensible milker trying to excite activity of the glands by gently rubbing the upper parts of the teats and the udder, also using other means to soothe and bring about contentment of the cow. Excitability may be the result of a natural timidity, or brought on, as is too often the case, by ill-treatment. The writer is inclined to think that milk formation is at its maximum during the process of milking and that the milk is not already formed, as we are led to believe, in the udder at the time of milking. One is further convinced by scientific reasons, and the fact that milk strippings contain a much higher percentage of butter fat than the first drawn milk, tends to confirm this theory.

Rugging Cows in the Colonies.—There are evils combating the good effects of the food and breed of milking stock. Exposure to weather has been shown to be one. To those opposed to rugging, the question might be asked, Why rug a horse when it is put out in moderate weather, and neglect to protect the cow in stormy weather? Compared with the average Australian horse a good cow is on equal terms of cash value, and we know that the milking machinery in the sensitive cow is easily deranged. A farmer who adopted the practice in South Australia at the suggestion of the writer fourteen years ago, was questioned on the subject and he expressed himself as follows :—

"Ever since I put covers on my cows there has been little variation in the quantity and quality of the milk yield. Before I rugged my cows, I have lost as much as 20 gallons of milk and 10 lb. of butter from the evil effects of one storm, and the cows have suffered to such an extent that extra feeding did not compensate for the injury through exposure. At present these storms have no injurious effects on them, and we never increase the feeding on account of rough weather. It might interest you to know about the first cow I put a cover on. She was a splendid animal, and had made as much as 17 lb. of butter in a week, and this was off the pan system. Before I covered this cow she suffered severely from cold, and would stand under a bush when it was raining and blowing. After being covered, in less than an hour she was out feeding in the rain, and within a week she had increased her produce by one-third; and I reduced her feed by nearly one-half."

"Have you observed if covering has made your cows more liable to contract cold or illness?"—"No; my cows are as healthy a herd as there is in South Australia, and are always in first-class condition. Tubercular disease has not been traced to any for the past four years."

The system of rugging cows in winter is now more general throughout Australia and New Zealand, and in the mild centres of England rugging might be attended with encouraging results.

Popularising British Breeds Abroad

An earnest desire is being shown by some foreign countries to improve all breeds of live stock. In Austria, Hungary, and Russia steps in this direction have been taken very successfully, and it only requires a sound system of advertising abroad to bring British breeds under the more direct notice of our foreign patrons. The writer has had personal interviews with foreign secretaries of agricultural departments on this subject, and has inspected all classes of live stock in Austria, Hungary, Roumania, and in other Near Eastern parts. In these countries there is a great dearth of good beef, and milking cattle, pigs, sheep, and draught horses, and inquiries and observations show that a British effort to place animals of suitable breeds in Austria and Hungary and other countries would meet with encouragement. It is true, consignments of cattle have already been sent to Austria-Hungary, but it is necessary to follow this up with a system of advertising, preferably the exhibition of representative animals at the leading shows on the Continent. An opportunity is before British breeders, and they should combine to take the fullest advantage of it.

An Objection.—The advertising of pure-bred stock abroad, and the export of stud animals from Britain, may not have the unanimous support of farmers and those interested in agricultural development. The chief reason given is the danger of increasing the dairy and meat imports, and the loss of stock of exceptional quality to British herds.

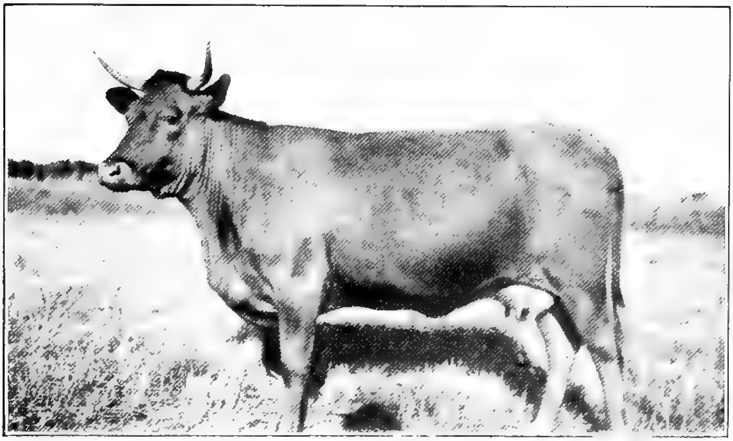


Fig. 34. Shorthorn-Balkan Heifer (Thomson).

There is certainly not much to be afraid of in Germany, France, and other Continental countries, where the local demand for meat exceeds production, and in the case of butter, a big import trade awaits development at certain periods of the year. In this question Australia is already keenly interested.

The export of live stock to America and Canada need cause no anxiety, as these countries are getting shorter of meat and butter every year, and are likely to be large importers from Australia and New Zealand.

In the South American Republic, British capital is developing agriculture, and it is natural that the live stock necessary for this purpose should be supplied by our own breeders. If Britain neglected the Argentine, another European power would take her place, and Britain would be a very serious sufferer in more ways than one. In provisioning Africa with stud stock only good will come, and turning to the Commonwealth of Australia, she is in greater need than ever of high-class dairy and beef cattle to increase her milk supply, and to meet the growing demands for meat and dairy produce.

If a slump in the butter market of this country is feared, it will have its fruitful side in arresting the imports of inferior margarine A scarcity of butter and cheese has been shown to be very hurtful to the dairy produce market in this and other ways.

If a real danger does exist by exporting cattle, a far-reaching remedy is at hand, namely, the development of the agricultural industries in Britain to cope with the greater demand for milk, meat, bacon, etc. In a report of the British Dairy Farmers' Association, it is stated that the imports of milk and cream into the United Kingdom for the five weeks ending 5th January showed that of fresh milk 2,248 cwt. had been received from abroad, against none in the corresponding period of 1912; of cream 1,175 cwt., compared with 727 cwt.; of preserved milk 1,395 cwt., against 161 cwt.; and of condensed milk 124,538 cwt., compared with 123,831 cwt.

A limit in the sale of females to foreign countries might be considered more particularly in the case of horses for army purposes.

It is certainly not the export trade to the Continent of choice dairy bulls and cows that is responsible for an invasion of the English milk market by the foreigner. British dairy breeds have very strong rivals in the Friesian and Simental breeds of the Continent, and if Britain is determined to safeguard her laurels, one way of doing it is by open competition. The importation of dairy stock from abroad is prohibited by Britain, no doubt chiefly because of the possibilities of introducing disease; but, strange to say, the raw produce of the cow is freely accepted, and without any particular safeguard against the milk carrying contagious diseases. Would not stringent quarantine laws entirely remove the risks of infection from imported stock? The danger, in the opinion of the writer, would be much less than the wholesale and unrestricted importations of grain, hides, and eggs from countries where foot-and-mouth disease and anthrax have a permanent home.

It follows that only a question of price divides the foreign buyer from purchasing the best of Britain's animals, but the law of this country prevents a similar privilege being extended to those desirous of making selections of bulls and cows from world-famous dairy herds on the Continent.

Let us go farther, and suggest the purchase from across the channel of the finest milking breeds of goats and sheep. Milk is growing scarce in some parts of Britain, to the injustice of consumers in the smaller towns and villages, and experiments might be tried in the way indicated with very great success.

In some departments of agriculture Britain stands unique, in others of vital concern she has shown little enterprise. Foreigners say we are conceited, and too proud to learn, and that Britain is merely living on her past reputation. If these criticisms are analysed in a practical way, something will be found to stimulate thought. In cattle breeding we are the envy of the world, but in practical dairy and agricultural research, America, Canada, New Zealand, and Austro-Hungary may be said to have accomplished most. Russia is awakening, and she may show an energy that will surprise the world. She has an enormous supply of raw material; only the skilful worker is required to make the best use of it. Britain will probably be a prominent teacher of the Russian, as she has been in many important

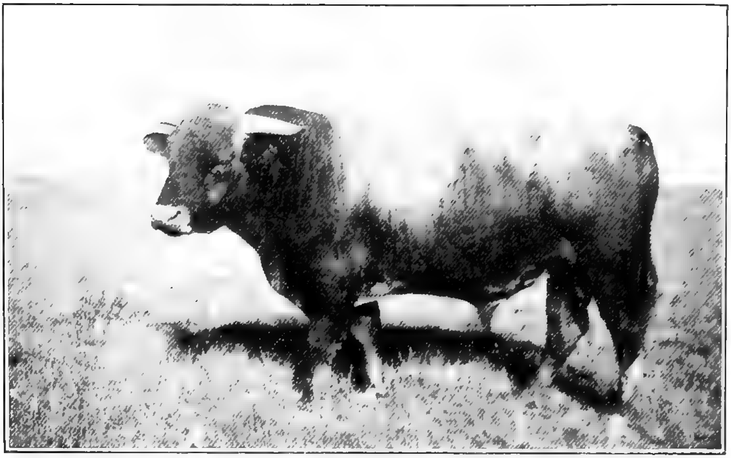


Fig. 35.—Shorthorn-Balkan Cross (Thomson).

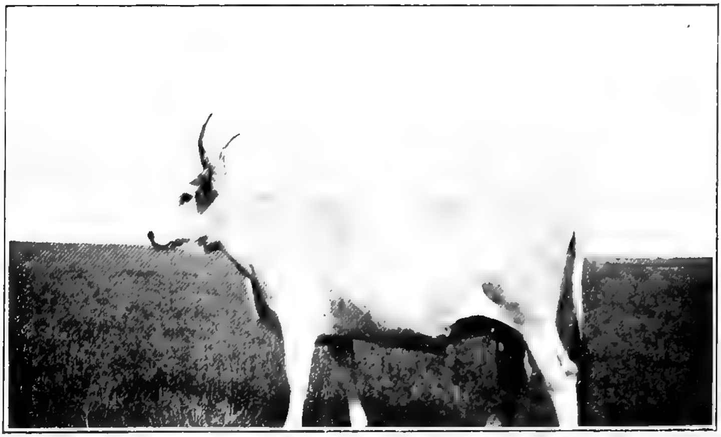


Fig. 36.—Mother of Bull (Thomson).

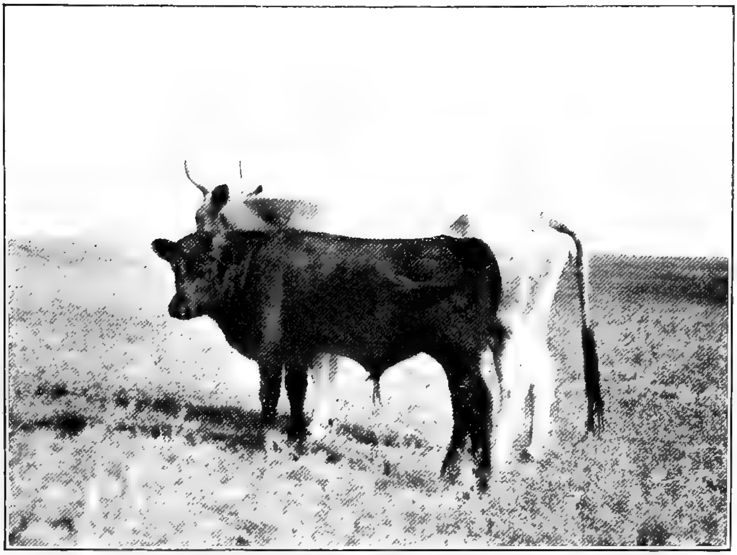


FIG. 37. Balkan Cow with her Crossbred Aberdeen-Angus Calf (Thomson).

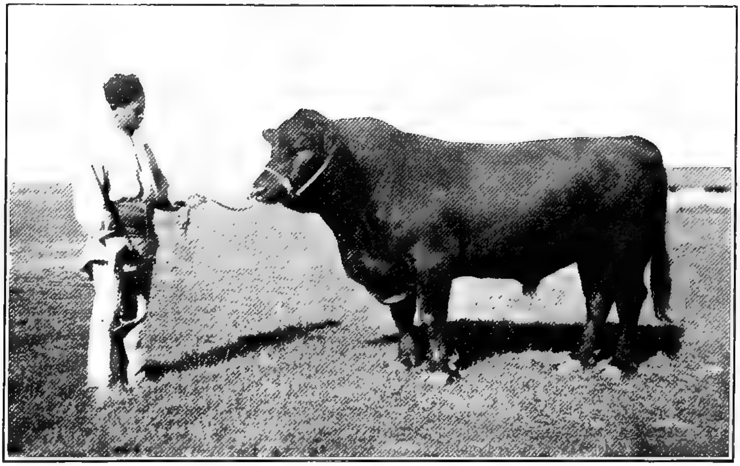


FIG. 38. Calf on Reaching Maturity (Thomson).

developments abroad. Foreigners possess a wonderful ability to copy what is of best value to the farming industries of their country, and in some branches of practical agriculture the alleged semi-primitive man has taken the bit of progress in his teeth and is leaving his better educated brother behind. In Near Eastern countries, for example, you will find the peasant with his own binder, reaper, seed drill, double plough, and other requirements that one is surprised to see in his possession, and you will find the telephone in use on farms of importance, because it is found to be indispensable to the business man. Britain has stuck religiously to many costly practices. Consider for one moment the amount of horse flesh that has been sacrificed in dragging cumbersome vehicles along hilly roads, when the American or Australian pattern of buggy and the light and durable harness would have met all requirements.

Agricultural Machinery Abroad.—There are splendid opportunities in Russia and other European countries for agricultural machinery. It is regrettable that Britain is so poorly represented ; in fact she is not represented at all in some very important centres except by native commission agents, who push anything that comes easy and profitable. They are the shop-walkers of all nations. The language difficulty appears the greatest obstacle to British travellers abroad ; but that could be easily remedied by commercial houses giving inducements and preference to men who are able to speak French and German. Showing how sadly defective Britain is in this direction, the writer had occasion to go to a prominent business centre in a very thriving agricultural country, and at a commercial house he found a number of natives who spoke English. Asked why they had learned the English language, one said, " We have gone to great expense and trouble to speak the language ; because England won't send us travellers who can speak to us, we must, therefore, go to England to speak to them."

If Britain only knew how well her travellers and merchandise would be received in some countries abroad, she would wake up, and not allow her commercial rivals to enjoy a rich harvest without exertion. In every foreign capital commercial Britain should be strongly represented by well qualified officials, who would be the servants of all, and whose duty would be to make the manufactures of Britain that are in greatest demand better known to the native population.

Stock-Raising on the Dairy Farm

English dairying at the present time is largely confined to the growing of milk for use in London and provincial cities. This branch gives the farmer a quicker return of cash than any other department of dairying. With a strain of heavy milkers, and further improvement possible, he can achieve considerable success. But farming for milk alone is attended with danger to the dairying industry as a whole, particularly if the present practice of destroying calves continues. This is certainly a sacrifice of animal life that will have to be reckoned with in the near future, when prohibitive prices will be demanded for dairy cows. Those who possess a knowledge of the home and foreign meat trade realise that prices are going to rise owing to a falling off of imports and home supplies. Also it should be remembered that new and attractive markets are being found for Colonial and foreign meat, and it is unlikely that shippers and importers are going to neglect business opportunities on grounds of sentiment. By giving a part of their attention to the Continent they will profit in both markets. Farmers should seriously heed the warning, and improve and replenish their herds by a better system of breeding and rearing of the young stock. Having this object in view, first of all let us ask ourselves why so many calves are destroyed. It is largely because they are inferior, and as milk production receives the exclusive consideration and attention of the farmer, and with the entire disposal of the milk, the profitable rearing of calves becomes impossible.

Now let us see what is responsible for the inferior calves. The answer is not difficult to find. The average dairy bull is not of high quality for breeding purposes, and a fair sprinkling of the cows are of a moderate standard. It should, therefore, be the first aim of the farmer to secure a bull that will raise the value of his calves, and it is no exaggeration to say that £3 would be obtained for good calves a week to ten days' old. But the question arises, Is the producer able to provide a good bull? Many are not. There is a way out of the difficulty, however, if a scheme were put into effect on lines which will now be described. In South Australia a great advance was made in dairying and agriculture by the work of associations throughout the State. These were affiliated with the Department of Agriculture which had control of the scheme. Members of the association were principally practical farmers, who met monthly and read papers and discussed subjects of interest to dairying and agriculture. Twice a year a conference of representatives of each district association was held in the various divisions of the State, and these were attended by the Government experts, who addressed the members and settled questions of importance. At the close of each year a general conference took place, presided over by the Minister of Agriculture, and attended by Members of Parliament, officials of the Department of Agriculture, and representatives of all the associations. Subjects of vital concern to the dairy farmer were brought forward at this conference, and invariably settled to the satisfaction of the farmers. Amongst the questions that claimed close attention was the distribution of bulls amongst the dairying districts, and under the care of the associations. The bulls were subsidised by the Government, and selected by the Department of Agriculture to meet the requirements of each district. The good these bulls did was reflected in a marked increase of stock and improvement in the milk and cream supply. It might further be said that a monthly journal of agriculture was issued free to members by the Government, which contained the papers read by dairy farmers and others at their meetings, and a *résumé* of their debates, also the departmental experts contributed on various practical questions. They also visited the districts periodically and lectured to the associations of farmers. The railway expenses of members attending conferences were defrayed by the Government, and they also enjoyed excursions arranged by the Department to places of agricultural interest.

Milk Tests and Improved Breeding.—We have referred to the action of the South Australian Government in assisting dairy farmers to improve the quantity and quality of milk. In order to ascertain the progress in this direction, reports were furnished by the factories of the monthly averages of fat in the milk received from the farmers. The following table gives results from four divisions of the State.

District and Factory.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Upper North												
Wilmington -	3.7	3.7	4.1	4.3	4.1	4.1	4.0	4.0	4.0	4.0	3.85	3.7
Hill's District—												
Gumeracha -	4.0	4.1	4.2	4.2	4.1	4.1	4.0	3.8	3.8	4.0	4.2	4.4
Clarendon -	4.2	4.0	4.0	4.2	4.2	4.4	4.6	4.4	4.0	4.2	4.2	4.2
Kondoparinga -	3.7	3.7	3.7	3.7	3.5	3.5	3.6	3.6	3.6	3.6	3.7	3.7
Middle North—												
Eudunda - -	3.8	3.8	3.8	3.6	3.6	3.6	3.6	3.6	3.8	4.0	4.0	4.0
South-East—								3.9				
Mount Gambier -	3.7	3.7	3.7	3.9	3.7	3.6	3.6		3.6	3.7	3.8	3.9
POUNDS OF MILK PER POUND OF BUTTER												
Upper North—												
Wilmington -	24.1	24.3	21.7	20.8	21.9	21.9	22.4	22.7	22.7	22.1	23.2	24.3
Hill's District—												
Gumeracha -	22.5	22.0	21.0	21.0	22.75	22.75	22.75	24.0	24.0	22.5	21.0	20.0
Clarendon - -	21.12	22.14	22.11	21.7	21.7	20.12	19.15	20.2	22.15	21.8	21.12	21.1
Kondoparinga -	22.5	22.5	22.5	22.5	23.5	23.5	23.0	23.0	23.0	23.0	22.5	22.5
Middle North—												
Eudunda - -	24.0	24.0	24.0	25.0	25.0	25.0	25.0	25.0	24.0	22.0	22.0	22.0
South-East—												
Mount Gambier -	24.4	24.3	24.0	23.4	23.9	23.9	23.8	23.9	25.0	25.9	24.2	23.9

These figures illustrate where improvement in the breed has been more marked. It may also be correctly inferred that climate and food have contributed to changes in the fat reading. This, however, can only be properly understood by those having a knowledge of the districts named.

The Work Ox

We have referred to the subject of dairying and meat production, and it may not be out of place to add a few lines on the value of the work ox to the small farmer. The writer has carefully studied the ox, and he appeals to one's sense of admiration in a strange and wonderful way.

The ox is used in Hungary and other countries for every branch of farm labour, and there is really nothing he is unfitted for that a horse can do. He will take his place in the plough at 4 A.M., and continue to work strenuously for nine hours or more, with only a half hour's rest during that period. For carting in rough and heavy country the ox is unequalled, and he will remove loads of grain that would astonish admirers of the horse. Waggons laden with sixty sacks of wheat drawn by six bullocks for miles along almost impassable roads is a sight frequently witnessed.

Extremes of temperature and weather conditions dreaded by the British breeder are viewed with no concern to live stock by the peasant in Eastern Europe. Without doubt the Balkan ox has no rival in the world for hardiness and endurance, and his food would be despised for bedding by many British farmers. Man and animal are matched for the work they have to do, and they do it with apparent benefit to health and strength.

Bullock Beef.—In the northern areas of Queensland the writer can remember the part the draught ox takes in the haulage of timber, and there his flesh is appreciated for its flavour and nutritive value. In the Balkans little else is eaten in the name of beef but the flesh

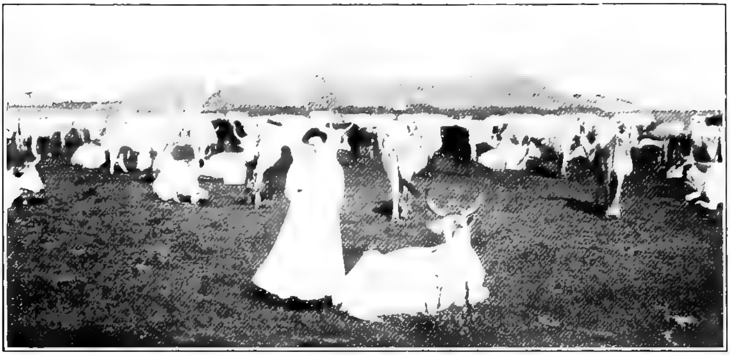


FIG. 39. Draught Bullocks Resting (Thomson).

FIG. 40. A Hasty Mid-day Meal (Thomson).

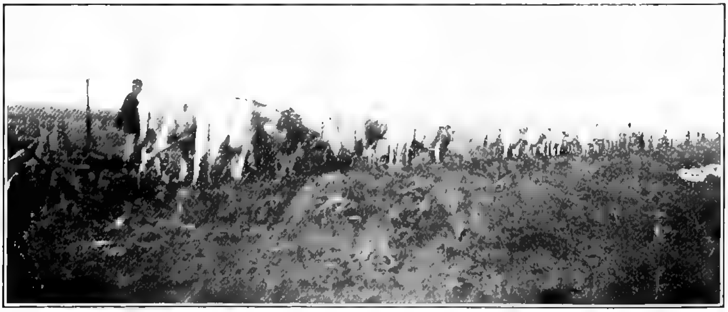


FIG. 41. Ploughing Heavy Maize Land (Thomson).

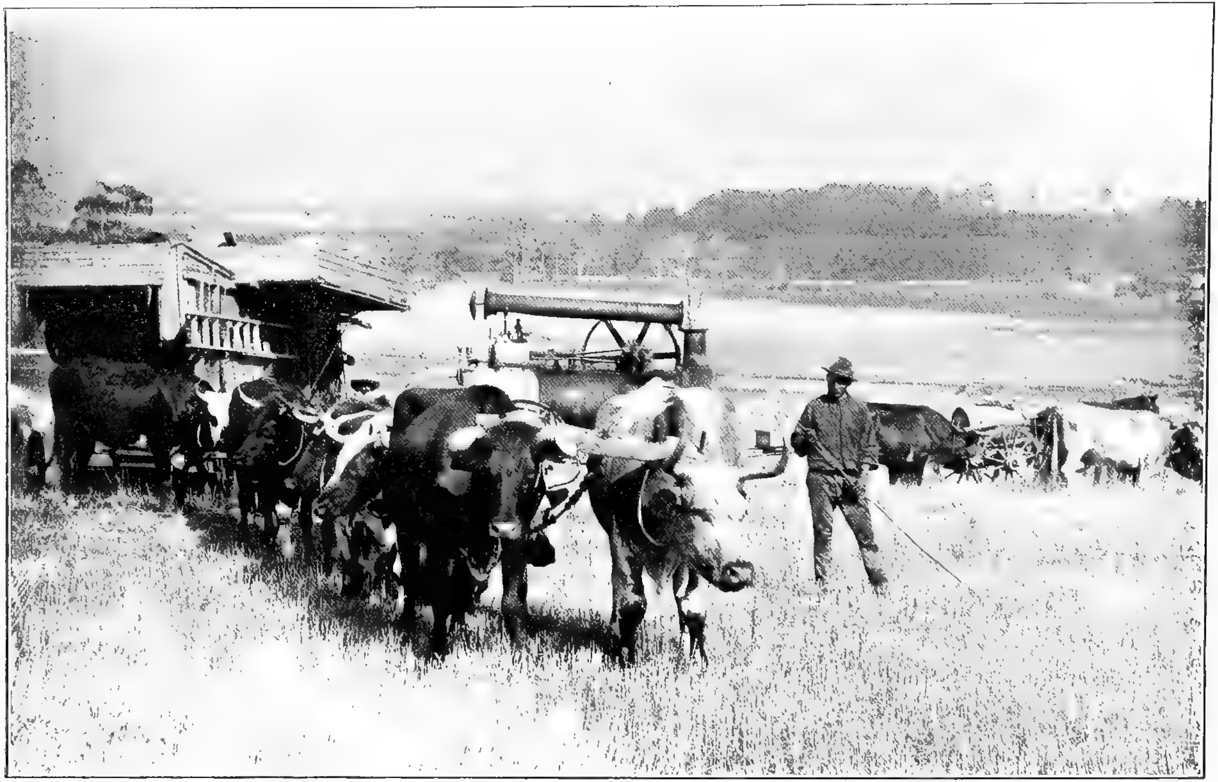


FIG. 42. A Scene in Northern Queensland, where the Draught Bullock is Appreciated.

of the fat work ox. Towards the end of the summer season thousands of aged and worn-out animals are bought up by maltsters, brewers, distillers, and others to fatten for the winter markets. The royal families and rich and poor are consumers of the meat. There are cuts of bullock flesh that surpass in flavour and tenderness the best parts of British fed beef, but the percentage of choice meat is certainly much higher with the home beasts. The good quality of bullock beef is accounted for in this way. Hard work develops a muscular condition in the animal, and reduces all superfluous fat to a minimum. When the years of labour are over, and the bullock is housed in a warm building and given abundance of easily digested food he fattens readily, and the muscular fibre becomes changed to a jelly condition. It may be said that the whole meat structure undergoes alteration from a dry, tough, and flavourless state, to a juicy, digestible, and well-flavoured meat. It must not be thought that the draught cattle in Eastern Europe are all small. Some parts are noted for the size of the "breed," and the heaviest framed animals the writer has ever seen were in foreign countries.

Draught Oxen for Small Holders.—From what has been said of the work ox, there may be reason to repent his extinction in Britain. Why should the crofter go to the expense of horses if the ox can supply his want? This animal is hardy, enduring, inexpensive to feed, and if the Balkan custom is followed, no harness and no shoeing would be required, and the theory that a draught bullock is useless for beef may be dispelled.

Cattle Foods

In the foregoing chapters practical illustrations are given of different phases of our subject, which readers might refer to. In the cultivation of crops for dairy cattle, the farmer must first of all look to his requirements, consult the capabilities of the soil, and draw upon experience of the district for much of his guidance. One has to remember that soil and climate dominate the cropping, and no matter how intelligent and progressive a farmer may be, these factors must be respected. But good methods of cultivation, and a sound knowledge of practical farming, will go far to establish men on the soil. Bad methods will end in disaster, and theory without practice can only be enjoyed by those who take up farming as a hobby. Granted we have good soil and a good climate, let us cultivate the land as it ought to be. Every class of soil must be treated according to its requirements, and what is done in one district might be fatal in another.

Foods.—A common question is asked, What is the best food for milking stock? The answer is "natural grass," simply because it contains all the constituents required for the formation of milk, flesh, and bone in the animal. There are many grasses and clovers cultivated and growing wild. Some are very sweet and nutritious, while others have a lower feeding value, and are not favoured by cattle. Varieties of grasses suit varieties of soils, and in different countries different grasses abound; some are perennial, some flourish for two or three years, and some only last the season. In some divisions of hot, dry countries the annual predominates, and it only requires an hour or two's rain at the proper season to transform in a few days great expanses of country from a brown parched earth to a beautiful green. In Britain the grasses are, as a rule, carefully cultivated, and a high standard of purity is reached in pastures. War is made on weeds, including couch grass, and other plants are singled out as particular enemies of grass lands. In Australia, South Africa, and Eastern countries, where the summer is hot, and rain sparse, couch grasses are the backbone of many "pastures"; without it disaster would befall stock. But the couch has changed its life in these countries; differences of soil and climate have made it nutritious and valuable. It therefore follows that what is a weed in Britain turns out to be a fine grass in other parts of the world. And the grasses

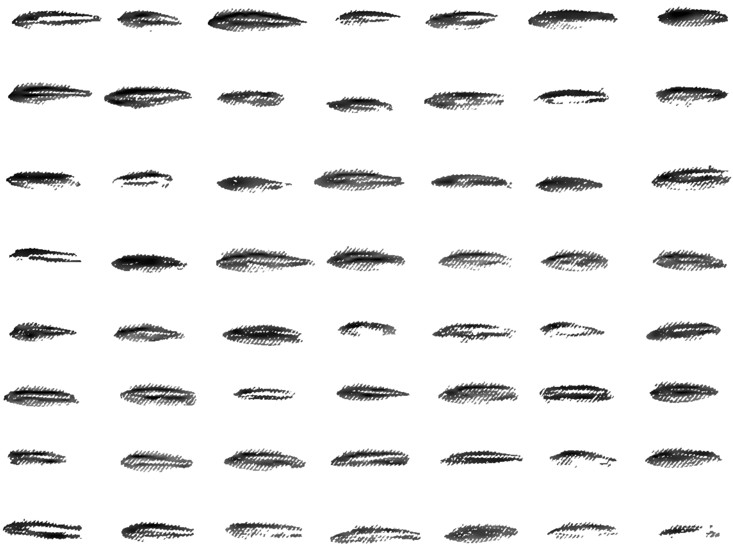


FIG. 43. Soil Experiments.

Showing average sample of grain grown in dry season under ordinary conditions of cultivation (Thomson).

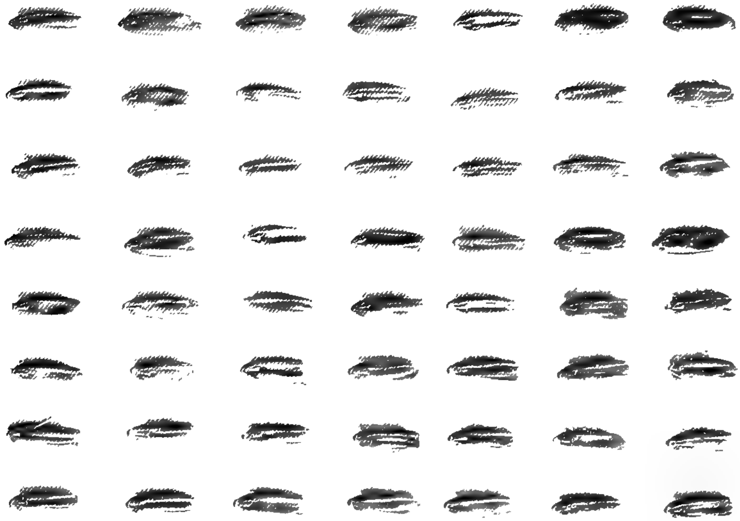


FIG. 44.—Soil Experiments.

Average sample of grain from the same quality of seed, grown by the writer on the same soil, but under improved conditions of cultivation (Thomson).

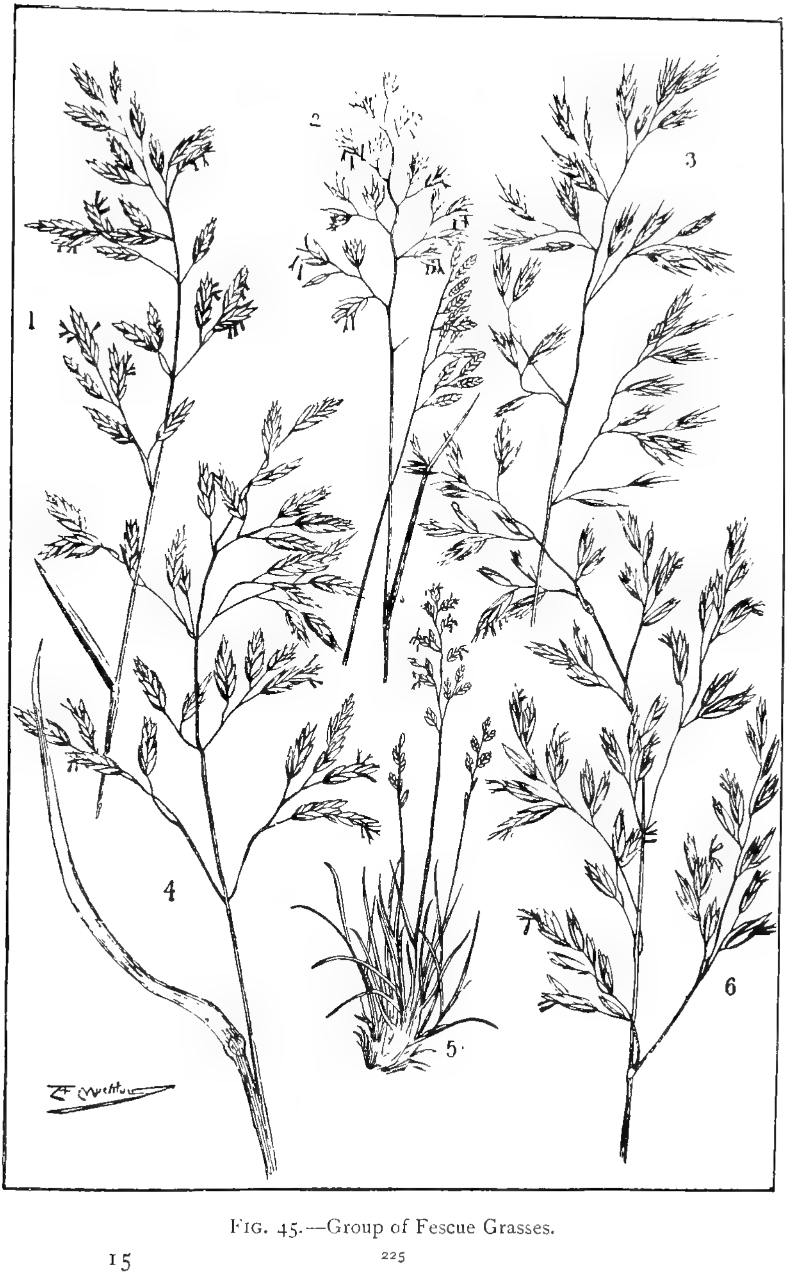


FIG. 45.—Group of Fescue Grasses.

and weeds that Nature provides in the countries named are of a higher feeding value than the finest cultivated grasses in the old world. Experience of fattening stock proves this, and what would be considered splendid feed and plenty of it by the dairy farmer in the Colonies, would be called weeds or starvation by the visitor "from home."

In South Africa good results have been got with Phalaris and Golden Crown grass, or "Paspalum," as it is familiarly called, but the fescue family has proved more profitable.

In Eastern Europe, with its hot, dry summer and severe winter, the tall fescue has no superior, and on the uncultivated lands this variety may be seen growing abundantly and to perfection. Also cocksfoot is a grass that stands drought well, providing there is a good depth of rich soil.

In our Colonies the cultivation of grasses should be one of the foremost subjects of a State Agricultural Department. Abundant scope is given for the propagation of grasses indigenous to the country, and the acclimatisation of imported varieties should be regarded as a special branch of practical research. If the subject were taken up with enthusiasm a great deal could be done to provide a more abundant supply of natural food, and this would confer enormous benefits on the dairying and live stock industries.

Seed Mixture.—In laying down a three or four years' pasture in Britain for dairy cattle the following mixture should prove suitable:—

Perennial rye	10 lb.
Italian rye	4½ ,,
Tall fescue	5½ ,,
Meadow fescue -	4½ ,,
Cocksfoot	4 ,,
Crested dogstail	2 ,,
Timothy	1½ ,,
Red clover	1½ ,,
Alsyke clover	1 ,,
White clover	2 ,,
	36½ lb.

For New Zealand and the better parts of Australia the quantities would be altered to suit the climate. The fescues, cocksfoot, and perennial rye would be considered more suitable than the other grasses in the mixture. In the drier parts of Australia and in South Africa the tall fescue, paspalum, with a little cocksfoot, would be principally sown.

In the cultivation of grasses every farmer should be an experimentalist, and on his own land he should determine which grasses and what quantities of seed will give the best result.

Perennial grasses require perennial conditions of soil and climate, so to speak, and this the farmer should bear in mind.

Changing Nature's Ration.—Too little attention is given to the value of changing cows from one field to another, or from the cultivated to the uncultivated pastures, or *vice versa.* The writer has had indisputable evidence of the wonderful influence changes of this kind have upon the flow, richness, and flavour of milk, as well as upon the health of cows. Changing the ration of stall-fed dairy cows will also give beneficial results, and experiments should be made by practical farmers to demonstrate the system of feeding that is most profitable and successful. A great deal of food that goes to waste could be utilised in rations in a very payable way.

Lucerne.—This is probably the richest nitrogenous crop in cultivation. It grows to perfection in hot climates, and where the soil is deep and provided with a good supply of moisture, enormous crops are reaped. In the cultivation of lucerne good tillage is very necessary, and a fine seed-bed must be provided. In parts of Australia great success has been achieved with the crop; in the Argentine it is very extensively cultivated, with the best of results, and in parts of Europe where the winters are extremely cold, and the summers hot, lucerne claims the attention of numerous farmers. Valuable as the crop is, care in feeding is necessary, not only to prevent taints in milk, which are mentioned elsewhere, but to prevent injury to cattle and sheep. Climate exercises a wonderful effect on the properties of lucerne, and in some countries the dangers of hoven in cattle are considerable; even the hay from the stack has to be fed sparingly.

Ensilage. In countries subject to droughty conditions, the conservation of fodder to tide over the months of scarcity is a very wise and necessary provision. Ensilage is a splendid safeguard, and numerous illustrations could be given of its value as a substitute for grass and other foods during periods of drought. Ensilage can be made from almost any green crop. The following may be named: Barley, oats, rye, wheat, lucerne, peas, vetches, clover, cow-pea, Keffercorn, Japanese pearl, and other millets. Of the heavy crops, maize and sorghum are very useful, as a big yield in favourable seasons is assured, and the process of digestion that takes place in the silo changes the fibrous character of the food into a condition that is readily digested and assimilated by stock. Where surplus herbage is abundant it should not be allowed to go to waste; its conversion into hay or ensilage should receive the attention of the farmer. In making sour and sweet ensilage the following conditions should be observed (Quodling):—

"*Sour.*—In appearance it should be of a pale green colour, and should have a pleasant vinous aroma, with a slightly acid flavour. Dairymen favour this class for milk production. The controlling factors in making are as follows: The crop requires to be cut when succulent, and it must be carted and siloed directly after cutting. Silo must be filled rapidly, and thoroughly tramped all over. The temperature must be kept at from 90-120° F., but the lower temperature is most in favour. To keep in the region of the nineties, quick filling and trampling must be resorted to, whilst above, from 100-120° F., the filling may proceed each day. To lower temperature when filling, mass must be consolidated by trampling, and then add more silage. If full, and the temperature is rising, lay down some bagging, and put on a layer of earth or handy weighting material, allowing it to remain.

"*Sweet.* In appearance it should be of a nut to dark brown colour, and have a rich, fruity aroma. The controlling factors in making are as follows: The crop must be cut when succulent. The process of filling must go on gradually, sufficiently so to allow temperature to rise. The temperature may rise from 120-150° F. Best results are obtained at temperatures ranging from 130-140° F. It is often necessary to fill on alternate days, or else arrange for crop to lie for a few hours, or overnight in the field, before carting in. Sweet silage may be made from wilted maize or sorghums, which have gone beyond the usual succulent period, but as temperatures usually run high, it is necessary to apply pressure. In a sectional view of a stack the lower layers are of a pale green colour, and may be classed as 'sour'; this is accounted for by the exclusion of air, consequent upon weight of stuff as above. As the temperature rises as higher layers are reached, silage gets darker in colour. At 160° F. it becomes almost black and 'mow' burnt, and deteriorates in quality."

Considering the question of root crops on the dairy farm, one naturally asks what crop is of the highest value for milk production? The mangold may claim the honour; it is relished by cows, and little or no bad effects on the flavour of the milk are traceable to its use. The crop is a gross feeder, and responds to abundance of manure. Nitrate of soda and common salt are much used. In growing mangolds, a point worthy of attention by those who are fortunate enough to have favourable land for their growth is the period when the crop is ready for use. Often the mangold is pulled and given to cows before maturity is reached. This is a mistake, as the food has a tendency to cause purging. When growth has ceased the crop should be pulled, and the leaves removed, or, better still, give the leaves to the stock at intervals after full growth and before pulling. The tap root must not be broken or injured, neither the crown, else the mangold will bleed and decay. The mangold should be pitted or put into rows, and covered with earth to ripen, when the best results from feeding will be obtained.

Cows should be fed according to their bodily requirements. A cow is not a machine. Some breeds turn their food into milk, others into milk and flesh, and we have breeds that belong essentially to the beef class. We may take the Hereford as a good example. When a cow has a fattening tendency, her attainments as a milker will be reduced, as the milk glands will be rendered less active, brought about by a fattening of the tissues of the udder. Opposed to this we have individual cows and breeds where the demands are greater upon the blood in the production of milk, and those are our heaviest milkers, but poorest in flesh ; for example, the Jersey breed. In the Shorthorn, with their combined qualities, we recognise that liberal feeding is necessary to support the double demands of milk and flesh. When the blood, however, is enriched by abnormally high feeding, the surplus nutriment is converted into flesh, and if the excess be from carbonaceous matter it will be changed into fat.

A New Forage Crop for the Colonies

The writer's residence in Eastern Europe gave him a good opportunity to make a practical study of a forage crop known by the name of "Dughia." This is an annual which resembles timothy in its more vigorous growth, but Dughia has a higher percentage of leaves. In Hungary and the Balkan States the crop is extensively cultivated, and is the chief food of horses and cattle in the winter months. Experiments conducted to test the feeding value of Dughia showed that cattle and horses fed exclusively on the hay fattened very steadily, and kept in perfect health. Dughia is sown either by

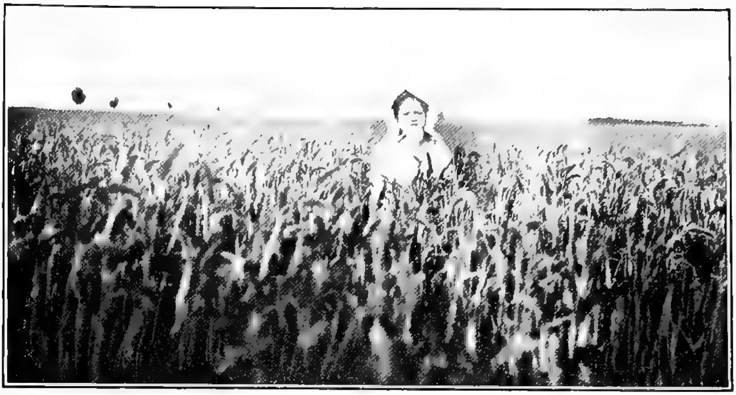


FIG. 46. Dughia Hay ready for Cutting (Thomson).

FIG. 47. Cutting Dughia (Thomson).

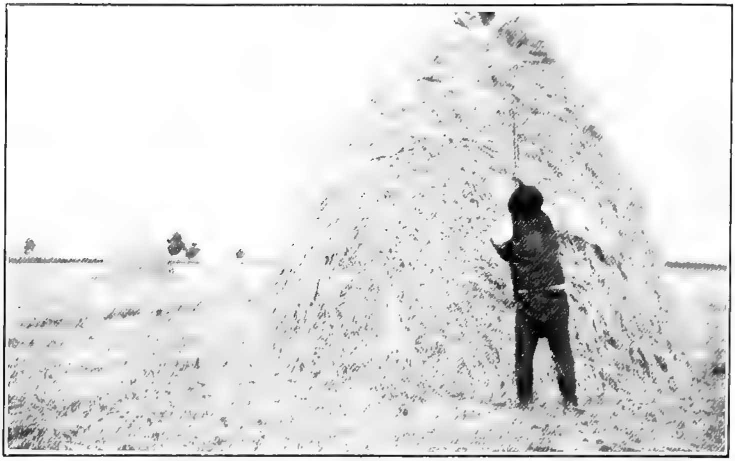


Fig. 48.—Servians Cocking (Thomson).

Fig. 49.—Dught Stackyard (Thomson).

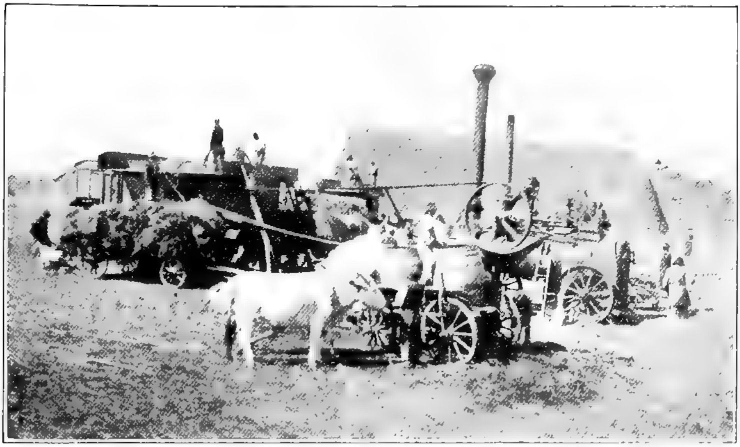


FIG. 50. Threshing Dughia (Thomson).

In Hungary the seed has a good value and the threshed hay makes a useful fodder.

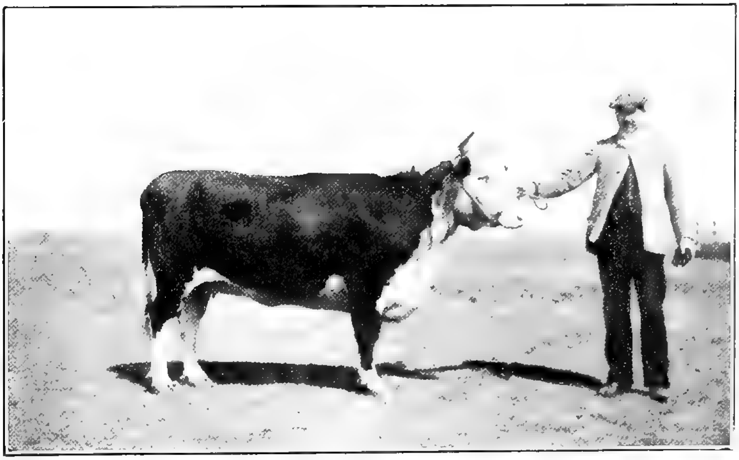


FIG. 51.—Fattened on Dughia (Thomson).

hand or the drill, and a half-bushel of seed is usually allowed per acre, but this varies according to soil and rainfall.

The crop is a lover of heat, and withstands drought exceedingly well. It is without doubt admirably adapted for cultivation in South Africa and the Australian Colonies, and might be successfully tried in the dry and warmer parts of England.

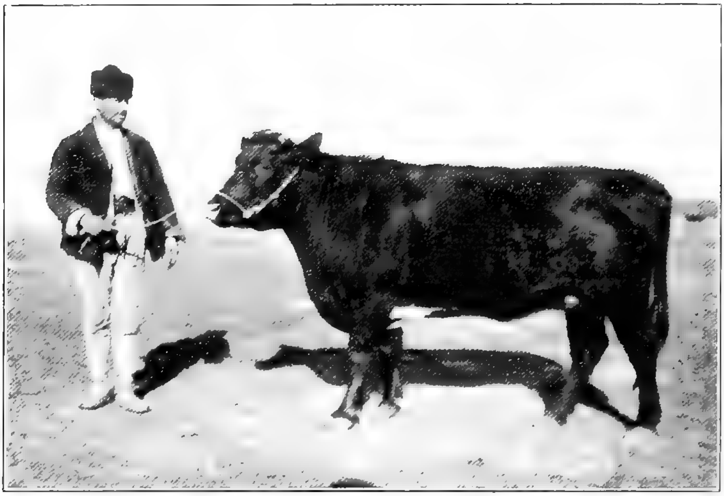


Fig. 52. Fattened on Dughi (Thomson).

Cattle Diseases

This is a subject which, strictly speaking, belongs to the veterinary practitioner, but as many agricultural districts in our Colonies are without veterinary surgeons, a practical knowledge of the common ailments of cattle is necessary to the dairy farmer. We shall deal with a few diseases in a simple way.

TUBERCULOSIS

This disease is found in cattle the world over, but its greater prevalence in some countries and in some breeds should help to guide our efforts in combating the scourge. In Russia and Switzerland, for example, tubercular disease is far less prevalent than in France, Germany, or Britain, and in the Highlands of Scotland the native breed is practically immune compared with cattle in the south. What deduction can we take from these facts? It is largely the upbringing of the cattle that has inured them with a stronger constitution, and established in the breed a condition that defies the attacks of the germ of tuberculosis. The skill of the modern breeder in meeting the demands of the milk grower and showyard has proved eminently successful, but at a sacrifice to constitution. We all agree on the necessity to eradicate tuberculosis from herds, but we may be guilty of inattention to the foundation of health and vigour in our future stock. It is out of all consideration to suggest that breeders should adopt the methods of the Russian or the Balkan peasant, but he should keep in mind that lessons are to be learned from these countries, that, if applied whenever practicable, would give to British dairy stock a degree of resistance against tuberculosis not otherwise obtained.

Factors that Destroy Tubercular Disease.—A healthy calf, descended from healthy parents and reared in a healthy environment, will meet the wishes of the breeder, the veterinary surgeon, and the public. To attain this very laudable end, there is much expense to be involved and difficulties and prejudices to be overcome. The writer agrees that an appeal to the purse of the State is necessary, for in a sense the State has been guilty of breeding the disease, and the expense of getting rid of it should fall upon the same shoulders. In the case of the horse, hereditary diseases are spread by "unsound" stud animals, and it is the law in some countries for stallions to pass a veterinary examination before being licensed for breeding purposes. This is as it should be, and why not apply the same law to stud dairy stock? Is it not the case that our cattle markets are open for the sale of tubercular cows and tubercular bulls? and knowing that the average bull is responsible for a large number of calves annually, some action to minimise the danger is necessary. The bull is certainly not so active an agent as the cow in disseminating tubercular disease, but he may give to his progeny a treacherous constitutional weakness. Killing off cattle advanced in tuberculosis is closing one door, but while the other door is open, eradication will be an unsolved problem. In Britain, anthrax is viewed with dread, and foot-and mouth disease with great alarm. The communicability of the former disease to the human being is very unusual—perhaps one in 10,000,000 is affected—and of the latter it is almost unknown; while if we believe scientists, the dairy cow is the greatest source of tubercular infection. Anthrax, and foot-and-mouth disease are attacked by the State with feverish energy; but as tuberculosis is not violently contagious amongst stock, although dangerous to man and very injurious to the dairying industry, it has been passed over lightly.

There is no country in the world that has a greater right to take the initiative in the cleansing of herds of tuberculosis than Britain, for she is the home of supply of stud cattle, and with every day of neglect an injustice is done to a national trade that has a far greater future than is generally imagined. The Tuberculosis Order which is to be enforced in Britain will be helpful.

Denmark is eradicating bovine tuberculosis in a manner that calls for the highest praise from every one acquainted with the methods she employs. It was proven in that country years ago that the raw separated milk was a medium for the conveyance of the disease to calves and pigs. In Denmark it is compulsory to pasteurise milk and cream used for buttermaking, which frees the separated milk, also the buttermilk from tubercular infection.

In New Zealand strenuous efforts are being made to purify the live stock of the farm, and the following paragraph by the Minister of Agriculture in his annual report for 1912, has a significant meaning:—

> "It is gratifying to me to know that the pasteurisation of skim milk and whey, in order to check the spread of bovine tuberculosis among pigs, a movement which I have endeavoured to foster in several ways, is steadily gaining ground. Though butter-making companies are not adopting this necessary principle to the extent they should, there is hardly a cheese-making concern in the Dominion which does not now heat its whey, and thereby make it a safe and improved foodstuff."

Symptoms of Tuberculosis.—The question may be asked, Can we not diagnose the disease without resorting to the tuberculin test? The symptoms exhibited by tuberculosis are not always indicative of the trouble, but may arise from another cause, and lead to grave errors. Fat and healthy-looking cattle may have the disease to an extent that the lungs present a mass of tubercular nodules. In this instance a casual examination by the layman is useless, and may lead to a feeling of confidence in the health of an animal until too late, when a sudden falling off in flesh points to the final stage of the disease. Bovine tuberculosis appears under two forms—acute and chronic. The former is generally of brief duration; death usually occurs within a few weeks. The symptoms of acute tuberculosis recorded by veterinary surgeons are as follows: A high temperature, quick breathing, glassy eye, dry muzzle, disinclination for food, and rapid emaciation. With a marked affection of the lungs a short cough is generally present, and the animal walks with a stiff gait and humped back. When the liver is affected the eyes may appear jaundiced; and with a diseased condition of the brain coverings the animal as a rule falls down and appears in a dazed condition. Should the bowels be the seat of the disease, purging takes place, with the excreta commonly tinged with blood. With an affection of the udder tubercular lumps may be felt with the hand, and when the joints are tuberculous lameness follows. In chronic tuberculosis the physical symptoms give little or no indication of the disease; but the chronic form generally changes into the acute, more especially in cows after calving.

Is Tuberculin Infallible?—The strength of tuberculin will vary for different reasons. Authorities state that if tuberculin is too strong it may cause the temperature to rise in a healthy animal, and if too weak it may fail to cause a reaction in a tuberculous animal. A rise of temperature may take place during the fifteen or eighteen hours after the injection, and yet be due to a cause other than tuberculosis. A confident case of disease in an animal is when the temperature begins to ascend a few hours after inoculation, and gradually rises two or three degrees, the maximum point being reached about the twelfth or fifteenth hour; afterwards it gradually falls to normal. Sudden ascents followed by sudden falls of temperature must be put down to some accidental disturbance. Excitement and strange surroundings will disturb the bodily temperature of an animal, and failures in tests are met with when tubercular disease is far advanced. Cows which have not reacted ought to be tested at intervals, as between the moment an animal is infected and the formation of actual lesions in the lungs, for example, a certain time must elapse.

There is risk of error to inoculate cows when in season as their temperature somewhat fluctuates. Why cows advanced in tubercular disease do not react to tuberculin is supposed to be due to the infected animal becoming so accommodated to the presence of the microbe and its products that an injection does not result in any marked systematic disturbance. Professor Bang puts the reliability of the tuberculin test at 87 per cent.

Tuberculin is prepared by growing the bacillus in a glycerin bouillon; it is then sterilised, and after concentration is filtered through a porcelain filter, and is ready for use. Much importance must be attached to the source from which the tuberculin is procured.

The following directions for using tuberculin are issued by the Veterinary College, London:—

1. While under the tuberculin test cattle ought to be kept in the house, fed on their usual food, and protected from draughts. They ought not to be allowed to drink large quantities of cold water between the sixth and eighteenth hours after injection. It is well to take their temperature at least once on the day preceding the test.

2. The dose of tuberculin for a medium-sized cow is 3 c.c., or 50 minims, and it may be varied a little above or below that, according to the size of the animal. Large bulls ought to receive 4 c.c.

3. It ought to be injected under the skin with a clean hypodermic syringe. The most convenient points are in front of the shoulder, or on the chest wall behind the point of the elbow. The best form of syringe is one with an asbestos piston, as the whole instrument may be sterilised by boiling it in water for five minutes before use.

4. The tuberculin must be injected into the subcutaneous connective tissue, and care must be taken that the whole dose is introduced.

5. Ordinarily the temperature must be taken at the time of injection, and at the sixth, ninth, twelfth, and fifteenth hours afterwards. When there is any reason to suppose that the animal may have been already tested with tuberculin during the preceding two or three weeks, it is advisable to take the temperature at the third and sixth hours as well as at the times just mentioned.

6. Animals in which the temperature, during the fifteen hours following the injection, rises gradually to 104° F. or more, may be classed as tuberculous, and those in which it remains under 103° F. as not tuberculous. When the maximum temperature attained is under 104° F., but over 103° F., the case must be considered doubtful, and the animal may be retested after a month.

7. The test is not reliable in the case of animals in the last

stage of the disease, or in those in which the temperature is over 103° F. before injection.

8. The tuberculin should be kept in a cool place, and protected from light. Should it become turbid or cloudy it must not be used.

9. The tuberculin test does not render the milk in any way injurious. Where the injection takes place on the animal's body, the part is thoroughly disinfected to avoid contamination with foreign germs.

The following is an example of the rise of temperature in a reacting case, and a slight variation when no disease is indicated :—

	Temperature Twenty-four Hours before Inoculation.	At Inoculation.	After Inoculation.			
		6 A.M.	12 noon.	3 P.M.	6 P.M.	9 P.M.
Reacting	101.7	102.4	103.6	107.4	106.1	104.5
Free -	102.0	102.1	101.1	101.9	101.6	101.1

FOOT-AND-MOUTH DISEASE

By the dairy farmer this disease is viewed with great concern, because of its very contagious nature, and the restrictions that are in force to prevent its spread. It is true Britain pays compensation for slaughtered animals, but heavy losses have to be borne by owners in other ways, including the prohibition of cattle for export. Foot-and-mouth disease, anthrax, and swine fever may be classed amongst those scourges that are imported from parts of the world where they are both permanent and prevalent. Laws in some countries are unfortunately very elastic, consequently the results are highly dangerous to countries with a clean bill of health. In discussing this question it must be taken into consideration, however, that in some parts of Europe geographical difficulties stand between animal diseases and their suppression; eradication is impossible.

The writer has had a good deal of experience of foot-and-mouth disease abroad, and has studied its effect on different breeds of cattle. It was shown that the disease is severest amongst heavy breeds, while light ones may take it in a mild form. In Britain, with so valuable an industry as the breeding of high-class cattle, strong measures to prevent the spread of foot-and-mouth disease and anthrax are very necessary.

Some Practical Observations

In an extensive grain-producing country, where the heat is frequently intense for five months of the year, and the temperature in winter commonly falls to zero for weeks, foot-and-mouth disease breaks out and attacks cattle from frontier to frontier. The stock owners in this part of Europe have no dread of foot-and-mouth disease; they look upon a visitation as a matter of course, and they assist its spread in order to shorten the period of the "outbreak." On one occasion in the early summer of 1911 the writer inoculated a mob of three hundred head of draught cattle with the disease, so that every animal would be in a condition for work at harvest time, and no delay occasioned through an invasion of foot-and-mouth disease at that critical period in farm labour. In carrying out the inoculations the cattle were drafted into lots according to age, size, and condition. Valuable herds of English cattle were kept at this farm, comprising the following breeds: Shorthorn, Hereford, Aberdeen-Angus, Ayrshire, Jersey, and Guernsey. Nothing could be done to prevent the spread of the disease amongst the English stock, which with the above included seven breeds of English sheep and three breeds of pigs. It was of considerable value to study the disease as it affected the various British breeds, compared with the native cattle, sheep, and pigs, and to note the class and condition of animal that provided the best seed-bed for the activity of the microbe.

Immunity.—In countries where the working ox predominates, a general outbreak of foot-and-mouth disease takes place once in every three or four years. Cases of the disease, however, may be found in the intervening seasons. This might be attributed to the immunity of the cattle following on a full attack of the disease, while those that had either escaped the invasion, or suffered only slightly, were affected usually the subsequent season. Virulent though the disease may seem, it is quite possible that in Britain where extremes of climate are less likely to destroy or cripple pathogenic bacteria, the microbe of foot-and-mouth disease may assume a more deadly form. Further, it is possible that the germs of an animal scourge may be distributed in a country without an immediate attack on the live stock, and a year or more may pass before the microbe manifests itself in a thoroughly active or deadly form.

How the Disease may be Spread to other Countries.—Three years ago foot-and-mouth disease was particularly troublesome in Eastern Europe. As the outbreak was at its height during the harvest season, all draught oxen that were able to drag along in the hundreds of binders in use were kept at work. Under the pressure of harvest it was very noticeable to what extent the animals passed saliva from their affected mouths, the strain increasing the flow considerably. In accordance with the practices pursued in the cutting, carting, and threshing of the grain crops and grazing of the stock, it became impossible for the grain to escape contamination with the saliva, and the greater portion of the season's output of wheat, oats, barley, and linseed was shipped to centres in France, Germany, and England. There was good cause to believe that the bran from the wheat was a fertile medium for the spread of the disease, not to speak of the danger from the grain of other crops.

Hides.—There is another source of infection, but unlike the one recorded, it can be controlled so as to afford some protection to British stock owners. This danger is associated with the practice in countries where foot-and-mouth disease is prevalent of destroying old animals that are unable to pull through. Their skins are sold to travelling dealers, who in turn transfer them to the exporter for shipment. Not only can foot-and-mouth be spread by this means, but anthrax is carried by the same agency, and thousands of skins from cattle that have perished from anthrax are transported to large houses in the tanning and leather trade. Precautions are necessary to prevent the shipment of hides on vessels carrying grain and cake to Britain.

Eggs.—The foreign egg trade has an element of risk which should not be overlooked.

Maize.—Owing to the tremendous acreage of maize owned by individual farmers in Eastern countries, whole villages of peasants are engaged to harvest the grain. These villagers bring to the maize fields during the season their families and entire live stock, which comprise draught cattle, pigs, and poultry. In fulfilment of the general contract entered into with the farmer, each peasant is allotted a section of maize to pull, varying from one to ten acres, according to the size of his family. As many as five hundred families may be seen at work in one field of maize, and as each family owns on an average four working bullocks, besides pigs and poultry, one can imagine the number of animals that are in contact with the maize crop. The maize is picked and removed from the fields according to two practices. First, transport roads are made at certain distances apart in the field, the maize cobs are picked, leaving the sheath or outer covering on the straw, and the cobs are put in heaps where the roads have been made. Hundreds of carts drawn by two, four, and six bullocks remove the maize from the fields to the granaries, but not usually before damage has been done to the grain. Seldom a heap of cobs escapes contact with the bullocks, as they persist in eating as much as they can from the heaps. Bullocks suffering from foot-and-mouth disease take part in the work of haulage, and it is a usual thing to see affected animals with saliva dripping from their ulcerated mouths, trying to eat the maize from the heaps. The second practice is to pull the unsheathed maize from the standing straw in the fields, and to cart the cobs to the peasant's family camping ground, where the younger members strip the sheaths from the cobs. The camping ground is the temporary home of the peasant, his family, and his live stock, and it is the practice to nurse sick, helpless animals around the maize heaps, thereby exposing the grain to infection. But the danger is not so great on large estates as on the peasants' own holdings. In such cases each cob is handled three, four, or five times before being finally received for export. The peasant first of all pulls the maize cob with the sheath adhering, and puts the cobs in heaps in the field; when convenient he carts the grain to his camping quarters, and there again each cob is handled in the stripping process. The maize is next removed to his homestead to be stored, frequently in a dirty shed amidst insanitary surroundings. During the winter months the peasant and his family will either thresh the cobs with a hand machine, or if the quantity is large a steam thresher might be used. He may keep the threshed grain at his holding for weeks before it is disposed of to the agent of an export house.

Infection of Grain by Vermin.—Field rats, mice, and birds are numerous in maize fields, and they do very serious damage to the grain contained in the heaps. Again, in the granaries, rats do great havoc, and thousands are killed at the threshing of the crop. The maize granary may rightly be termed the autumn and winter residence and breeding ground of farm rats, and when in close proximity to a maize granary on a winter day one can readily tell by the smell that rats are present in great numbers. In certain large maize-producing countries rats have no shelter except in the maize granary, because, unlike Britain, the wheat crop is threshed in the fields, and the wheat straw burned. Quantities of barley and oat straw are kept for farm requirements, but rats don't choose to spend the autumn and winter in stacks unprovided with food. To increase the danger of infection already referred to, maize granaries are invariably used in the summer months for the drying of hides, removed from animals that have either been killed or died from infectious diseases common to the country.

Linseed a Carrier of Disease.—It is quite within reason to suspect imported linseed carrying foot-and-mouth and other diseases to Britain.

Infection by Wind and Birds.—Those who have experienced wind storms in Russia and countries in Eastern Europe will quite understand how readily dust may be transported hundreds of miles; in fact, from one country to another. In practically all countries that largely depend on thunderstorms for their rainfall, cyclonic winds generally precede the rain, and the sky for miles may be seen darkened with dust hours before the storm breaks. It therefore follows that the microbes of cattle disease are readily carried in this way. Again, there are migratory birds that gather in hundreds of thousands at the close of the summer season, and then depart to other countries. In their flight they have their stopping places, frequently the autumn barley and wheat lands, also the maize ground, where grain is eaten in considerable quantities.

Human Infection from Animals Suffering from Foot-and-Mouth Disease.—It is questionable if there are reliable records to show that this disease has ever been communicated to many persons. The writer has seen numerous sick bullocks and hundreds of farm labourers drinking from the same troughs day after day—in fact peasants drink water direct from the pails after infected animals have had their supply, without suffering any ill effects. This should be sufficient to prove that the disease is not at least readily communicable to human beings.

Suggestions to Minimise the Introduction of the Disease into Britain. In the case of grain imports, representation should be made by the British Government to continental Governments to exercise the greatest possible care to prevent infection being introduced into Britain, which has always been comparatively free of the disease.

A strong agricultural committee should be formed in England, to confer with leading agricultural associations on the Continent, with the same object in view.

A thoroughly practical investigation should be conducted into all possible channels through which foot-and-mouth disease may be brought to Britain from continental countries.

Arrangements should be made for responsible Government officials to gain actual experience of the disease in countries where it is prevalent, and to thoroughly understand how infection is conveyed from one country to another through the medium of exports.

ANTHRAX

This disease is dramatically sudden in its effects. An animal may to all appearance be quite healthy one hour, the next hour it is dead. Partly on this account anthrax is known as "sunstroke" by the peasantry in some parts of Bulgaria, and partly because the death-rate is highest when the summer heat is greatest.

Animals in prime condition suffer most, and in the Balkans the lean work bullock that lives out of doors is the least affected. Anthrax is a genuine test of constitution and hardiness.

Infection may be spread in a number of ways, a fertile source being the bones of animals that have died of the disease, contaminated soil, and which may be transported by wind. In Britain the laws affecting animal diseases are justifiably stringent, and no conscientious farmer should ignore them. In our Colonies, where farms are far apart and distant from veterinary surgeons, anthrax might exist without the disease being known to the farmer or stock owner. Needless to say where there is a handy supply of wood the unopened bodies of anthrax victims should be burned to the last cinder. With a scarcity of wood the carcass should be buried to a depth of at least six feet, being previously treated with petroleum or shell lime if obtainable. If death takes place within a building drastic measures are necessary to disinfect everything that may harbour the dreaded enemy. Fodder and litter should be burned. If an animal perishes near the homestead, it is a wise precaution to burn straw where the carcass lay. There is very considerable danger from infection of the ground from the blood that is usually emitted from the bowel and mouth of the animal at the time of death, and the natural openings of the body should be plugged with tow soaked in disinfectants.

When anthrax is suspected, a post-mortem should not be made. The spleen of anthrax victims is usually enlarged and engorged with blood, and when one is in a position to use the microscope an examination of the blood should in no case be omitted. Only one drop is required for this purpose, and a characteristic feature of the disease is the fluid and tarry appearance of the blood, and its staining properties.

TICK FEVER

Dairy farmers settling in South Africa, New South Wales, and Queensland should make themselves acquainted with the preventive treatment against tick fever and which is advocated by the Departments of Agriculture of Cape Town, Sydney, and Brisbane. Up to present dipping stock has given the best results in keeping dairy herds clean of the disease.

MILK FEVER

This disease generally attacks well-bred milking stock, likewise cows in high condition and heavy milkers.

Symptoms.—Evidence of disease is shown in from twelve to thirty-six hours after calving, and the symptoms are recorded as follows: Cessation of rumination, dullness, lowering of the head, arrest of milk secretion, paddling of the hind feet, and a rolling and unsteady gait when walking, staggering and paralysis, and usually the animal falls helplessly to the ground; the head is frequently turned towards the flank, and rests on the side, the eyes are half closed, and the cow falls into a sleep, pulse is quick and breathing heavy, temperature may be as low as 95° F.

Treatment.—Prevention is better than cure. Keep the cow in average condition, and give a laxative before calving. The curative treatment, and the one adopted with considerable success by the old Scottish farmers, was whisky, and to-day whisky is still looked upon as a good specific. A renowned veterinary surgeon in Scotland some years ago recommended to the writer the following prescription for milk fever: Give two shillings worth of whisky in treacle water, followed with 1 oz. of chloral hydrate in treacle water, and $\frac{1}{2}$-oz. doses of chloral hydrate every three or four hours. Keep the animal well on its chest, and turn over occasionally, milk often, only taking away a little at a time The treatment now generally adopted is to inject medicinal agents into the udder, after thoroughly stripping the glands.

There is another form of fever which is sometimes confounded with the disease explained. It may occur up to the eighth day from calving.

IMPACTION

This trouble has carried off a very large number of milking stock in the Colonies. It is due to stomach weaknesses. Want of a sufficient supply of water and succulent food during the dry months causes paralysis of the third stomach. A cow having recovered from a bad attack of impaction is very liable to take it again, but in a more severe form, when a cure is beyond reach. It will pay to ward off this disease by providing green feed for the cows, which aids in the digestion of the dry stringy fodder. When constipation is first observed the animal should immediately receive treatment, as it is in the earlier stage that a cure is effected.

Symptoms. — Constipation, fullness of the flank, grunt in breathing, disinclination for food, milk flow stopped, thirst, bad breath, staring coat.

Treatment.—Doses of linseed followed by 8 to 12 oz. of Epsom salts, 2 oz. tincture of gentian, 4 drms. of aloes, given in 2 qts. of gruel. The linseed will have a softening effect upon the hard dry food in the stomach, making way for the action of the salts.

Cows very often suffer from dyspepsia. The cause of the trouble is scanty feed, exposure to cold, and bad drinking water.

Symptoms. — Irregular and diminished appetite, and affected animal shows a desire to lick walls, stones, and woodwork, and they may eat dirty straw, sand, stones, etc. A special craving seems to exist for bones. The cow may exhibit rheumatism, and the fibrous tissues of the bones may become the seat of the disease.

A trouble which is not uncommon is softening of the bone. A deficiency of phosphates in the food is associated with this ailment. It is recommended to give finely-ground bone mixed with bran, chopped hay, and salt. When affected with stiffness, animals usually draw the hind legs when walking, the joints swell, and movement is difficult.

HOVEN

When cows gorge themselves with green lucerne, cabbage, clover, or sorghum the rumen or first stomach becomes swelled by the accumulation of gases. The left side exhibits a greater enlargement than the right. When hoven is first noticed relief may be given by dashing cold water over the body, and by gagging. In bad cases it is advisable to pierce the stomach: a place on the left side is taken midway between the last rib and the haunch bone, and about 5 in. from the spine. The following medicine is sometimes given: Liquor ammonia, 1 oz.; cold water, 1 qt.; essence of ginger, ½ oz. Mix and administer carefully, when the trouble is not advanced.

RETENTION OF THE PLACENTA, OR AFTER-BIRTH

Causes.—Debility preventing proper contraction of the uterus, poor quality of blood, long journeys by road prior to parturition, exposure to cold, accidents.

Treatment.—Epsom salts, 8 to 10 oz.; gentian and ginger, 1 oz. each, to be followed in twenty-four hours by a 2-oz. dose of sweet spirits of nitre. The above is one of the best prescriptions yet adopted. If the placenta is not removed by the medicine, then apply the hand, but much care is required in doing so.

SPOTTED TEATS

Cows are sometimes troubled with hard red spots on the teats, which give rise to considerable irritation and inconvenience during milking. With affected animals it is advisable to milk them last, afterwards applying the following mixture to the teats: Crude sanitas oil, one part; glycerin, four parts; olive oil, six parts. Milkers should exercise care to prevent the spread of the trouble to the unaffected cows.

WOODEN TONGUE, LUMPY JAW, ACTINOMYCOSIS

By some authorities this disease is believed to be communicated by the food. In actinomycotic abscesses, barley awns have been found, also pieces of straw and husks of cereal crops.

Yellow and colourless grains are observed in the abscesses, which is characteristic of the disease.

Treatment.—In the early stages dress the tumour with a tincture of iodine. Iodides may be given internally, but the dose should not exceed 3 drms. daily. With this treatment cows go off their milk. Heavy doses of Epsom salts have the same effect. Applications of ammonia are said to check actinomycosis.

ABORTION

Very great care is necessary to prevent the spread of this disease. The veterinary surgeon should be called in in all suspicious cases. An important discovery in connection with abortion is announced by the London Veterinary College.

BLIND TEATS

This is exceedingly common in all countries, and few herds are free from imperfect teats. (See "Milking," p. 6.)

SWINE FEVER

British pig-breeding at the present time is suffering heavily from the ravages of this disease. It is also common in Continental countries, but according to the writer's observations the disease does not appear to be so infectious and deadly as in Britain. In Russia, for example, it is even less virulent, which is accounted for by the wonderful hardness of the native pigs. On the Continent excellent results have been obtained in the serum treatment of swine fever. Britain should give this subject serious consideration, also the introduction of the disease from foreign parts is a matter that calls for action. It would be very largely to the gain of British veterinary colleges, and British live stock breeders, if some Government provision were made to enable college lecturers to study the treatment of swine fever on the Continent, and to gain experience abroad of other stock diseases which threaten this country.

CHAPTER V

DAIRYING EDUCATION, MILK RECORDS AND LAWS

Education.—In preparing students for appointments as instructors, managers of factories, or in any important capacity, very great attention must be given to the nature and extent of the practical instruction. Within recent years dairying has come into wonderful prominence, and there is cause to believe that a great future is in store for the industry. We have only to look to Australia and New Zealand to prove what progress has been made in the production of butter and cheese, and what remains to be done before the industry attains its full development. This alone should suffice to show that only a system of education capable of meeting the growing demands of modern dairying can meet the wants of the future student. The question arises, Can this be obtained in England, Australia, or other countries where dairying has been established? Britain has given to the world many students who owe their training to the schools at Reading, Kingston, and Kilmarnock, but education at these centres is incomplete, which handicaps students who attain positions of responsibility as instructors advisers, or as factory managers. Training should begin early, not with difficult subjects, but with the rudiments of dairying, and when a knowledge of this has been acquired, the student is in a better position to permanently benefit from the more advanced teaching. This should deal thoroughly with every practical subject upon which the success of the student will depend, and the theoretical training should harmonise with the practice in a way that the greatest benefit will be obtained, and both money and time saved in the education of the pupil. On this subject the writer may be permitted to speak with some authority, having been trained in Scotland and England in dairying and agriculture, and having been fortunate to gain experience of those industries in different parts of the world. It is a true saying that one profits by experience, and this feeling has prompted the writer to treat his subject with an open mind, and it is hoped in a manner that will be accepted in the spirit it is given. Perhaps one is justified in stating that few industries exist in which the failings of education will manifest themselves more clearly than in dairying, with its many important phases, each demanding for the worker a thoroughness in training. In England and Scotland where factory dairying is in its infancy, facilities for the practical education of students qualifying for this branch are awanting. This, however, should not prevent those responsible for the curriculum of dairy schools from enlarging upon the training of students to enable them to successfully undertake the management of factories, and grapple intelligently and creditably with the difficulties that arise where butter is manufactured or bought on a large scale.

As this book will show, there is nothing more important to the practical worker than competence in the classing and ripening of cream. No dairy diploma or hall mark of efficiency should in the opinion of the writer be given to a candidate for college honours, unless he can show a knowledge of this subject, sufficient to guard against the many serious errors that are associated with the cream supply. Again, there is the classing of butter, which, it is true, can only be done in a thorough manner by a man of experience; at the same time a strong effort should be made to provide for the student the best possible training in so vital a branch of dairying. This may be termed a commercial subject, and perhaps some may go far enough to say it is outside the jurisdiction of the class-room. Whatever the attitude of the critic may be, there are indisputable reasons to include the grading of butter in the teaching at all important schools of dairying. As British educational centres are at present constituted, it reflects the highest credit on

FIG. 53. Professor R. J. Drummond.

the instructors that so many students have passed through their hands fully qualified in the subjects embodied in the syllabus of the various examinations. The writer can say with a feeling of confidence that in no country in the world is the practical education of students carried out with greater care and thoroughness than is observed in the leading institutions of Britain. And were the scope given for a sound education in additional subjects, as outlined in this chapter, the course of instruction would be so complete as to thoroughly qualify students for service at home and in the Colonies.

Scientific Research and Practical Knowledge. It has been suggested that the agricultural research scholars of this country should be interchanged with those of other countries for reasons which are given in this book. We are conscious that big changes are pending in agricultural teaching, and none will go farther to remodel all departments of the farming industries than a closer application of practice.

In the analysis of soils, a practical knowledge of agriculture would enhance the chemist's report, by giving to it a higher commercial value. It has been shown in a very forceful way that the future dairy bacteriologist and chemist should not only be an expert in the analyses of dairy products, but he should possess a sound practical knowledge of branches of dairying which are inseparable from his profession. Analyses of dairy produce is robbed of much of its value because of this want on the part of the investigator, and it may be said that scientific research also suffers severely for the same reason. Publications of laboratory work clearly illustrate how very valuable a practical acquaintance with dairying would be in the elucidation of scientific problems of vast importance to the industry.

The Curriculum

We shall deal with the chief omissions in college and dairy school education, and explain why they are regarded of paramount importance to students and dairy employees.

Dairy and Farm Book-Keeping.—This is a subject whose value cannot possibly be estimated, and perhaps no branch of education is more neglected. Book-keeping shows where energy is profitably or unprofitably employed, where money is well or badly invested in the farm, where intelligence and perseverance are rewarded; it proves the right from the wrong—in fact, it is the guiding star of the farmer.

There is such a thing as theoretical book-keeping which tells of much that has no sincere application to practical or commercial dairying. Book-keeping will do much to revolutionise farming, and the instructor who can handle the subject in a sound and practical way becomes an asset of immense value to every teaching centre. He will be able to show the easiest, best, and quickest way to ascertain the profit and loss of every branch of the dairy farm, and he will know enough of the science of agriculture to steer clear of dangers. A successful practical farmer possesses one of the highest qualifications for such a post, just as he is the right man to have a voice in all questions of agricultural education and development.

Refrigeration. Artificial cold plays a great part in practical dairying, and in no country can its importance be overlooked without loss and injury to the producer. In Australia, New Zealand, in Siberia and the Argentine, in Canada and on the Continent, all agree that great as the past has been in refrigeration, far greater results are anticipated. Dairy refrigeration may rightly be termed a separate department of the student's education, and particularly for those going to the Colonies in search of appointments, or to throw in their lot with the producer, is a knowledge of the subject necessary. In the preservation of milk and the ripening of cream artificial cold plays a great part; in the preservation of butter it is indispensable, and in research much has been accomplished. British students should know something of the good and bad systems of refrigeration; of its far-reaching influences over flavours, and of its worth to dairy science. No training centre should be without a complete refrigerating plant and modern chambers, and no curriculum is worthy of a British dairy school unless refrigeration receives the place its importance warrants. Cold is one of Nature's greatest preservatives; it has no poisonous properties like the chemical compounds used in dairy produce. To commerce its greatness has not yet been unfolded.

Factory Construction and Equipment.—In all countries giving prominence to the manufacture of butter and cheese the above subject commands a place in the education of the student. Thousands of pounds have been lost through faulty construction of factories and dairies, and many failures of promising companies have followed want of care in this direction. It is a fascinating subject to the student, as each department of a factory is linked with the scientific and practical activities of the cream-grader, milk and cream tester, refrigerating engineer, butter-maker and cheese-maker. The construction of the cream ripening rooms opens up a subject of great importance to butter-making, and the refrigerating chambers lend themselves freely to that department of practical investigation dear to the heart of the intelligent factory employee. In factory building, science and practice go hand in hand.

It is only within the past fifteen years that labour-saving machinery has been installed in butter and cheese factories. Doubtless the change has been remarkable, and the results have been equally surprising. One, however, must go further afield than Britain to gain a practical and scientific insight into the equipment of factories. In the most modern and up-to-date establishments in our Colonies it would be a revelation to the British student to see the time and money-saving machinery at work. The engineer, mechanic, butter-maker, and the practical scientist have combined and brought to a state of efficiency each appliance associated with the manufacture of butter.

Educational and Commercial Value of a Factory.—The factory is an enterprise with far-reaching influences in the agricultural development and settlement of a district and a country. On common grounds of education the construction of no factory should be permitted until the plans have been passed by a competent body, just as important educational appointments have to be endorsed or approved by a central authority, and city buildings by the council architect. A dairy factory, whether co-operative or privately owned, where milk or cream is purchased, should be a centre of practical education to dairy farmers on subjects which not only contribute largely to the success of the factory, but upon which the welfare of the farmers themselves depend. All factories should come under some provision in the management, making them an object lesson to farmers in the proper handling and treatment of their supplies, and without in any way interfering with the commercial object of the factory. And managers should be certificated, which would be an inducement for good men to come forward, and it would have the additional value of raising the status of their work.

Government inspection and government instruction should radiate from the factory to the farmers supplying the raw produce. No one is better informed of the weaknesses of the district, and no one is more familiar with the defects of the dairy, than the factory manager. He is ever willing and eager to co-operate with competent inspectors for the improvement of the milk and cream supply. It is to his advantage to do so, particularly as it reflects on the quality of the factory produce, and the financial success of the institution. Of a system of compulsory inspection and instruction the writer has perhaps had unique experience, and he can conscientiously say that it is the quickest and most effective way of removing obstacles from the progress of dairying and of raising the standard of produce. In young countries, inspection as suggested will greatly contribute to a healthy development of dairying and dairy farming.

Value of a Model Factory.—In every dairying country a model factory for the guidance of the industry should be established, preferably by the State. Such an institution would be built, equipped, and conducted on ideal lines. In England a model factory is desired, both for technical purposes and as an object lesson to the whole country. In Australia, New Zealand, and Canada the finest dairy factories in the world are to be seen; but had a model factory been erected in these countries when dairying was instituted, many thousands of pounds would have been saved to the industry and greater success attained. In South Africa the new factories of Gwela and Standerton, which are State-aided, should be invaluable for the whole Union.

Cream Testing.—This is a branch of technical instruction that should not be overlooked by the dairy school In oversea countries, where the hand separator is extensively used by factory suppliers, cream testing occupies a high place in the curriculum of the factory. It is not the practice of testing that involves any serious difficulty or danger, it is the numerous factors and conditions which affect the cream, that require to be understood.

How many employees in British factories understand how to take a sample of cream correctly? From the writer's acquaintance the average hand has much to learn in this direction. The county teacher's influence should be better felt amongst dairy hands, and were this done, sampling and testing would be put on a more secure basis. In the Colonies cream testing is a subject of vital concern to the industry. (See "Milk and Cream Testing" and "Grading Dairy Produce.")

Cream and Butter Grading.—Before completing his college education, the dairy student should be qualified to detect the commonest taints found in cream, butter, and cheese, and he should know their cause, and be able to advise steps to prevent their development. A theoretical knowledge of taints and flavours without ability to recognise them is of little value in practice.

Testing Glassware.—Glassware used in the chemical work of the dairy is frequently incorrect. The standardising of glassware is a duty the student should be able to perform, and he should be thoroughly competent to decide between the valuable and useless appliances and apparatus of the laboratory. (See Queensland Act.)

Commercial Dairying.—The relationship of this subject to manufacture is now so close that it should be embraced in the college curriculum. We have margarine making, butter blending, renovating, and other commercial enterprises that are conducted on highly educational and technical lines, all of which have a significant interest for the dairyman of the future. The whole face of dairying has been changed, and dairy instruction should accompany the advance that each year brings. The buying and selling of butter and cheese on the "iron," or, to be more correct, on flavour judged by the palate, is the rock upon which the success of the produce merchant depends. He should be qualified to discuss the merits of his produce with buyers, and in many cases the grocer gets more sound practical advice and instruction from the salesman than he can obtain from the local teacher—and that class of tuition is of the right commercial quality, for it speaks of £. s. d., the goal of practically every commercial undertaking.

Plea for a Commercial Course of Instruction.—There are strong reasons to be put forth in support of the founding of a course of commercial education in the broad department of agriculture. Some of the claims of dairying to be considered under such a proposal have been shown. The subject is national in its relationship to the people, just as the meat question concerns every consumer in the country. And might we ask, does it interfere with the rights and liberties of trade to educate the people to know good from bad produce, to purchase the honest from the dishonest article, and to demand fair treatment from the salesman?

Nothing will stamp out commercial "errors" more quickly than the ability of the people to choose for themselves. Laws unless effectively drafted and properly administered will offer temptations for the more educated and skilled of commercial practitioners to defeat, but an educated people will not be misled, and their individual laws violated from day to day. In the meat trade the salesman is supreme, he has few critics amongst his customers; they take and pay for what he chooses to give, and they may grumble, but that is the end of it. It is pathetic to say that not one woman in fifty thousand has the knowledge she ought to have of butcher's meat and other perishable products that make up the daily food of the household. Why should instruction not come to their rescue, instruction that will be practical, attractive, and simple to understand? Cookery classes are rampant in Britain, but they do not teach the future mothers how to select good from bad produce based on simple rules. Without this knowledge it is impossible for the instruction to be otherwise than faulty. Immediately the salesman finds his window and his shop analysed by the educated eye of the practical meat or produce judge he will wake up to his responsibilities, but not till then.

In the retail meat, butter and cheese trade, trickery is said to be openly and fearlessly perpetrated on the rich and poor alike, and that it will not cease until the consumer can say, my knowledge now helps me to distinguish right from wrong.

Let us now turn to other phases of our subject.

Dairy Co-operation.—The writer has been an observer of the birth of co-operation, and its development in a country of great potentialities. In a battle that raged between private enterprise and co-operation for a number of years, an opportunity was given to those interested to distinguish the elements of good in each case, and at the conclusion of this commercial war the summing up was a clear victory for co-operation. Private enterprise should, however, not be despised or abused, it has gone where co-operation has feared to tread, and it has been the forerunner to co-operative institutions the world over. Private enterprise has shown a courage and daring that must commend admiration, and it is for the co-operative enthusiast to respect these virtues. Dairy co-operation, of all organisations, offers a splendid field of enterprise and success for the farmer. Allied with a butter and cheese factory of modern design and equipment, under a directorate and management of intelligent and practical men, there should be nothing to fear. All are working for the common weal, so that every effort put forth by the farmer will redound to the financial benefit of the factory. This in turn will compensate the farmer by better prices for his produce, and a higher dividend on his invested capital. Co-operative organisations have an additional advantage over private enterprise—they can buy, manufacture, etc., under one directorate. A mighty future awaits the principle in Great Britain and other countries.

Dairy Instruction at Schools

There is no better way of establishing agricultural education on a healthy footing than by beginning at the country schools. In Australia many schools have their own experimental plots where varieties of grain are grown and other experiments and tests conducted. Schoolmasters take a great interest in agronomy; they keep in touch with progressive farmers, and the cream of the practical information gained is disseminated amongst their scholars. An interest in the land is instilled into the young people, and usually once a year the scholars celebrate what is known as Arbor Day. The youthful minds are turned to agriculture, and nothing else on such occasions, and inspiring addresses are delivered by Cabinet Ministers, Members of Parliament, and others on appropriate subjects. In a recent criticism of public school instruction a distinguished educationalist said that 20 per cent. of it was dangerous to the young, and 20 per cent. useless to them at all times in their lives. How much of this is correct is best known to the teachers themselves, but it must be admitted that radical reforms are necessary in the public educational system of most countries.

Golden opportunities are given to enrich the school curriculum, by making it more practical, and to teachers to show originality in methods of teaching. They might, for example, incorporate agricultural facts with geography in a way that would give dual benefits to the pupil.

It is regrettable that practically nothing is done to teach the young the fundamental principles of dairying. The subject has more than a close relationship with the food supply of every home, yet the ignorance that prevails of milk and its products is appalling. One hour's instruction per week on vital points of interest to dairying and the consumer would be helpful in very many ways. The teacher would be expected to deal with the subject discreetly, and in a practical and interesting manner. Milk testing for fat would be a fascinating bit of practice that no child would readily forget, and there are numerous experiments that would appeal to boys and girls in a very forceful manner. It was through the schoolroom that the writer succeeded in introducing some important reforms in connection with the dairying industry of South Australia. The scholars were the carriers of information to their parents, and they also took part in putting the instruction into practice. They knew that by careful handling of cows and careful milking much was gained by the farmer, and they knew how the milk and cream should be kept to return the highest profit. This class of instruction was easy to impart, readily absorbed, and simple to practise.

It is surely more valuable for the country boy to learn and understand the virtues of limewash, than to fix in his mind "all about" Teheran in Persia, or Cayenne in South America, and for the country or town girl to know that the sickroom and the dirty cupboard are not the proper places for the family milk supply. The curriculum of the country school without agriculture is, to say the least, a reflection on the modern educationalist. The pupil should be taught more of what governs his very existence, and less of the cramming of subjects that retards the success of those who are practically inclined. The boy who excels in memory study is often a failure in practice, and it is evident that the present-day system of teaching aims at satisfying qualities in the scholar which play a minor part in building up our national industries. It may, therefore, be said that a faulty system of country education has contributed to drive the people off the land to the permanent injury of a calling for which their talents, hardiness, and industry make them so eminently fitted.

The principle of teaching dairying as carried out at the Ednam School, Kelso, under the direction of Mr George M'Donald, should commend itself to the country schools of the United Kingdom. Ednam school is doing a great service to British Agriculture.

IMPORTANCE OF LOCAL CONDITIONS

In dairying, many phases of work have a local connection, and upon this, success is influenced. In the breeds and breeding of cattle, the raising of crops, and in the manufacture of butter and cheese local conditions are at work and they must be obeyed.

The man who gives instruction on all subjects of dairying from his office table takes upon himself a risk that is not consistent with education and experience, and although he might be surrounded by a library of technical books the danger will not be overcome. This view coincides with what has been said on the value of instruction on the farm. Again, visiting a country in search of agricultural knowledge is most useful, but it may give rise to errors of judgment. Residence in a new country will correct the errors of passing observation, because you have not only had time to observe, but to know the true value of practices for which the country may be renowned, and you are in a safer position to understand how much of this can be adopted with success in your own country.

INFERIOR COUNTRY BUTTER AND FARM TUITION

One reads that the future of England for dairying is imperilled because of the large quantities of inferior butter that are produced, notwithstanding the fact that year by year adds to the strengthening of dairying education throughout the agricultural areas. The manufacture of bad butter on the farm is no guide as to the value of England for the production of dairy produce. Bad butter is the fault of the maker, assisted by conditions which invariably go hand in hand in the manufacture of inferior produce. Where a few cows are kept, and collections of cream are held over for churning once or twice weekly, it is impossible to avoid the penalty, namely—a tainted product. Britain can claim to possess the qualities necessary to produce excellent dairy products, only this is not appreciated, and the industry is not developed to reap the reward the country offers. It is not in accordance with fact to say that Britain has not the climate, the soil, and the markets—the time has come to dispel once for all these excuses for the backwardness of dairying.

One might ask, when will countries learn that practical tuition on the farm is the most fruitful system of local instruction? Butter-making classes are often too theoretical, and are conducted under conditions too advanced to be of immediate good to the producer. And the same will apply to modern tuition in cookery for the poor and middle classes. The dairy instructor or instructress should go to the farm, and amidst the natural surroundings of the dairy, prove that education can effect improvement with the crudest of appliances, and in the face of difficulties foreign to the class-room. One successful demonstration will be enough to win the confidence of the intelligent farm butter-maker, and she will prove the best advertising media of technical instruction. There are thousands who owe much to help of this kind, as the writer has already said, but when the information can only be obtained at the expense of travel and inconvenience, the results are more likely to be abortive. Teachers of farm butter-making, poultry raising, and egg production should, in a sense, bring themselves to the level of the cotter, and from there work the salvation of the local industries.

Country Cinematographs

For purposes of public and school instruction free cinematograph exhibitions by county councils and educational bodies would be of immense value in agricultural districts. Modern methods of dairying could be beautifully illustrated on the screen, and the value of each clearly conveyed to the audience. Accompanied by a practical lecturer, the cinematograph would take the place of a modest travelling agricultural school. Conducted in connection with experimental work the results could be made known amongst all classes of agriculturists, and a keen interest created amongst both sexes, and young and old.

Agricultural Reading Rooms

In all county towns and villages in Britain there should be a free agricultural reading room and library, and where free bulletins on practical agricultural subjects could be procured. At present no encouragement is given to the practical man to improve his knowledge by this means, and although there are numerous large libraries in counties, poor provision is made for the agricultural reader who wishes to spend a wet afternoon or evening in acquiring useful information. In Australian villages the agricultural labourer can find scope for his wishes in this direction, and many benefit by the opportunities placed at their disposal.

Milk Testing of Cows

The following advantages are claimed for the grading of cows by the use of the Babcock tester and spring balance.

1. Weeding the unprofitable cows.
2. Selection for breeding.
3. Invaluable in the education of juvenile milkers.
4. Test of efficiency in milking.
5. Regularity in hours of milking proved.
6. Guide to feeding in stall or field.
7. Test of feeding experiments.
8. Test of good treatment of cows.
9. Test of weather on cows.
10. Test of health.
11. Check against adulteration of milk after it leaves the farm.
12. Quickest way to ascertain farm losses.

It is the farmers' guide to systematic dairying. Testing and simple farm book-keeping should be inseparable in showing the profit and loss on every cow on the farm.

This class of work is most acceptable to the sons and daughters of the farmer and should be a source of attraction in keeping them on the land. In the opinion of the writer no country school is replete without a milk-testing outfit.

The practice of ascertaining the fat test of cows' milk and the yield is becoming general in all countries. In

Scotland, where much success has been achieved, the late John Speir did good work in bringing the value of testing and milk records prominently before breeders and dairy farmers. The results of his labours are being profitably felt to-day in Scotland, by the greater popularity of the Ayrshire breed for the dairy. Milk testing is the best instruction the farmer can have of the value of his herd for dairying, as he is able to distinguish between the profitable and unprofitable cows. He should be advised to follow up improvement on the lines of practical experience, only more vigorously than hitherto. But before he makes any radical changes in his breed, or dismisses cows from his herd, all qualities should be taken into account. A cow may be a poor milker, but she may be a valuable breeder. This has a wide application. In the desire to get rich quick by the fat testing of herds mistakes may follow. A cow's milking qualities may be depreciated by conditions that are partly remedial, and when this is attended to, she may prove a very useful animal. To condemn her would, therefore, be a mistake. Again, it would be unwise to pursue the practice of testing without consideration for the beef or fattening properties of cows, for example the Shorthorn breed. Beef will get more expensive each year, and this should be borne in mind. The merits of the dual purpose cow should not be lost sight of, although in many cases it is advisable to breed for the dairy and nothing else.

Fat testing and milk weighing is of far greater value than one imagines. It will stand out more prominently than anything we know of in demonstrating the value of the bull as the strongest factor in raising the standard of dairy cattle. It is well to begin at the fountain-head and not at the estuary. Testing and weighing will also show how far the farmer may go in forcing the "standard" of his herd. The practice will check and control his ability, experience, and judgment no matter in which way it may be directed. The weakest parts in the national practice or system of breeding will be brought home to the industry and the remedy declared. This will give a splendid impetus to dairying by showing how greater profits can be earned.

When testing is put under proper supervision, injury from abuses will be safeguarded. The better influence of the sale ring will go far to help breeding and dairy farmers. There, cows will be sold with a practical milking pedigree, those with a poor pedigree will find their own level; but the danger of private sales of cows with faked or cooked records will require attention. When the practice of taking the fat test into serious consideration in the purchase of cows becomes universal, some authentic proof of the accuracy of records will be essential. Qualified testers under the control of the Government should be employed to check and initial records, and to control testing in each county or division. Only this class of independent man will give confidence and satisfaction. Such an officer would render other services to the county: he would be qualified to instruct farmers in the more technical branches of dairying, and, for example, advise them in carrying out the provisions of an Act. In short, the officials would be travelling instructors. The writer's experience of official testing dates back to 1898, and he has carefully watched its progress till the present day. Efforts have been made in different countries to put fat testing on a broad basis, but not always with success. This was through lack of enthusiasm and faulty methods. In some districts of Australia farmers were invited to send samples of milk to factories, depots, and other centres, to be tested free and at prices ranging from one penny to threepence per sample, but this met with failure. In Queensland the only system that gave satisfaction is the one already suggested. The instructor must go to the producer, and in the homely environment of the farm impart the information most desired. In Queensland the mounted tester is ever welcome at the homestead to show the dairyman how to manipulate the Babcock apparatus, and to teach the advantages of milk records. Farm testing is one of the weakest links in the chain of Australian and African dairying, and now that Governments have realised this fact, a rapid improvement may be anticipated in the breeding and rearing of more profitable dairy stock. Convincing proof of the value of testing is given in a Colonial Government Report, from which the following extract is taken:—

> "A herd of thirty-two dairy cows in Victoria were tested and gave for the year 16,658 lb. of milk, which produced 6,886 lbs. of butter, or 24.19 lb. of milk to the lb. of butter. The average return per cow was £7. 3s. 5d., but while the best cow made £10. 17s. 7d. with a test of 4.2, the worst made £4. 1s. 6d., the test being 3.7. Taking £4 as the cost per cow per year, including interest, food, and attention, it was found that while the ten best cows averaged a profit of £5. 3s. 5d., the ten worst averaged £1. 4s. 8d., while the worst milker of the lot showed a profit of only 1s. 6d. That particular herd of thirty-two cows had poor grazing, and the average yield makes it out as a picked herd, and if a picked herd shows so many varieties in yield of milk and fat content, the variations in an ordinary herd would be greater. The test is an aid to the farmer to level up his herd to the best standard."

In the last Report of the Agricultural Organisation Society of Ireland it is said there is no reason why the milk yield of Ireland should not be raised from 450 to 550 gals. per annum, which would mean a yearly gain of £350,000. In the Commonwealth of Australia the low milk yield of cows, compared with the average of the best of dairying countries in the world, gives a yearly loss of over £4,000,000.

Take the following as an example: The number of cows in one Australian State is put down at 365,000. Official tests of the herds in a large dairying district show that the highest average yield of milk was 21.4 lb. per cow per day, and the lowest average yield 5.3 lb. of milk.

Highest average butter-fat test was 4.9 per cent., and the lowest 3.3 per cent. Applying those returns to the 365,000 cows, the comparative results would work out as follows :—

365,000 milch cows of the highest average production would in 300 days return £4,500,000.

365,000 milch cows of the lowest average production would in 300 days return £970,000.

Compared on a tonnage basis it is found that 365,000 cows of the higher standard of productiveness would yield 49,000 tons of butter in 300 days, and 365,000 cows of the lower standard of productiveness would yield 10,000 tons of butter in 300 days.

In Denmark a steady improvement has taken place in milk records for twenty-five years, and this is calculated to have increased the wealth of that country by £800,000 per annum, or a total of £200,000,000.

According to the American standard no cow that fails to produce 280 lb. of butter and 5,000 lb. of milk per annum has a right to a place in a modern dairy. "Daisy," a Jersey-Guernsey cross, was said to have a record of 10,000 lb. of milk and 600 lb. of butter. In Britain a yearly yield of 1,000 gals. of milk is the aim of many breeders, and this is being exceeded by individual cows on a number of farms. At the London Dairy Show last October a seven-year old Shorthorn cow, "Modern Maid," at two milkings, morning and evening, gave 8½ gals. of milk. The cow was bred and exhibited by Mr James Sheppey, Bristol, and her achievement was at least a record for the show.

Some Achievements by Cows in Canada

In a Canadian Government Bulletin for 1912 results are given which are said to include world's records for milk and fat of pure bred dairy cattle. The following is compiled from the report :—

Ayrshire—Cows Five Years Old and Over

Name of Cow.	Lbs. Milk.	Lbs. Fat.	Per cent. Fat.	Days in Milk.
Eileen	13,825.75	635.48	4.59	365
Primrose of Tanglenyld	13,536	529	3.90	356
Pet of Hickory Hill	13,191	542.18	4.10	354
Flora of Metcalfe	11,908.85	427.34	3.59	365
Sybella of Springbank	11,468.8	428.08	3.74	307
Victoria	11,283.21	451.902	4.00	330
Dairymaid	11,100	571.77	5.16	365
Eileen	11,025.75	522.94	4.74	365
Duchess of Point Round	10,599.5	485.199	4.57	345
Lady Pearl of Burnside	9,226.25	328.34	3.56	287
Cows Four Years Old and under Five				
Scotland Princess 2nd	11,385.95	511.97	4.48	365
Molly	11,268.6	372.42	3.35	296
Cows Three Years Old and under Four				
Canadian Princess	11,377.55	521.91	4.59	335
Star's Sarah	10,651.04	407.4	3.82	365
Briery of Springbank	10,172.9	376.03	3.70	325
Scottie's Victoria	10,057.5	389.56	3.87	314
Cows Two Years Old and under Three				
Briery 2nd of Springbank	14,131.35	520.49	3.68	365
Butter-Maid of Craiglea	11,392.45	480.33	4.21	365
Speck of Springbank	10,353.65	437.39	4.20	365
Holstein-Friesian Cows Five Years Old and Over				
May Echo	23,707	833.64	3.51	365
Dekol Plus	22,304	764.94	3.43	365
Netherland Aaggie Dekol	21,666	704.8	3.25	365
Kate Castleton	18,713.5	580.58	3.10	365
Tempest Clothilde Mercedes	18,447.9	600.31	3.25	365
Vida Princess 4th	18,402.75	602.6	3.26	365
Helena Pietertje's Pauline	17,555.62	534.48	3.04	337
Beauty's Buffalo Girl	16,820.9	554.86	3.30	365

Holstein-Friesian—Cows Five Years Old and Over (continued)

Name of Cow.	Lbs. Milk.	Lbs. Fat.	Per cent. Fat.	Days in Milk.
Johanna Netherland Dekol	16,687.95	548.85	3.29	365
Edna Wallace- -	16,367.8	542.6	3.31	365
Jossie Bewunde Posch -	15,439.5	463.81	3.00	365
Maud Bessie Dekol -	15,240.75	433.74	2.84	365
Cow Three Years Old and under Four				
Desta -	18,993.39	568.32	2.99	365
Cows Two Years Old and under Three				
Lula Keyes -	19,258.45	542.67	2.81	365
Jenny Bonerges Ormsby -	16,849.16	666.32	3.95	365
Guernsey—Cows Five Years Old and Over				
Lady Heiress of Dentonia	8,925	430.74	4.82	365
Cow Four Years Old				
Dorothy's Heiress -	8,085.5	495.74	6.13	365
Cow Three Years Old				
Beauty of Hillside -	7,394.5	384.9	5.20	326
Cow Two Years Old				
Dairymaid of Hillside -	9,352	464.2	4.96	365
Buttercup of Hillside -	7,056.5	394.35	5.58	365
Jersey—Cows Five Years and Over				
Aristocrat's Fanny -	11,097.5	539.48	4.86	365
Brampton Blue Fly -	9,982.4	511.91	5.12	365
Cows Four Years Old and under Five				
Lady Buttercup of Pender	9,305.5	466.52	5.01	365
Golden Milkmaid -	8,442.5	409.41	4.85	328
Cow Three Years Old and under Four				
Lady Rose of Pender -	10,086.5	459.33	4.55	364
Cow Two Years Old and under Three				
Brampton Lady George -	11,001.85	445.63	4.14	365

It will be observed from the above records that the cows have been in milk up to the complete year. Such a lengthy period subjects the animals to a severe strain, and particularly if the practice is persisted in. It serves to show, however, what can be accomplished in the milk standards of cows, and opens up a new field for investigation.

District Registration.—In districts or counties in Britain a register should be kept of cows that have attained a certain standard for milk and butter fat. The test would require to be sufficiently exhaustive to be thoroughly reliable, in fact, the daily yield of milk and fat reading would have to be ascertained, as weekly tests are not a safe guide to the milking qualifications of a cow. These registers would be official, and published annually by the county. The scheme might be carried out on somewhat similar lines to that in force in Canada, and which has met with very great support by farmers.

In admitting cows to the Canadian register of pure bred stock they must not fall below the standard adopted for each breed. For example, let us quote the standard for the Holstein :—

	Lbs. Milk.	Lbs. Butter Fat.
Two years' old class -	7,500	255
Three ,, ,,	8,500	289
Four ,, ,,	9,500	323
Mature class	10,500	357

In the Canadian scheme it is specified that the owner of cows competing for registration shall provide board and lodgings for the inspector during his official visits, and shall convey him when leaving to the railway station, or the next farm to be visited, free of charge.

Bulls.—Bulls of each breed are admitted after having four daughters in the Record of Performance, each from a different dam.

In all departments of testing it is stipulated in the

Canadian rules that the butter fat shall be determined by the Babcock test.

Milk Testing in Sweden.—In Sweden there are about 5,000 milk testing associations. In the cowshed of the small farmer the milking pedigree of each cow may be seen, so universal is the practice of testing. Cows that are officially registered in Sweden must show a yield of milk not less than the average of the cow's mother, and the mother of the bull.

When is a Cow at her Best?—Observation goes to show that milk cows are at their best between the ages of five and ten.

Factors governing the Quality and Yield of Milk.

The following are the views held by the writer :—

- A. Fat per cent.
  - Breed, and maintained by
    - Sire.
    - Dam.
    - Time of year of commencement and completion of maternity period.
    - Individuality.
  - Food
    - Quantity and quality to satisfy individual demands. Degree of maturity. A cow with a strong individuality for milk, and if her food requirements are neglected, the fat content of her milk may suffer a temporary or perhaps permanent reduction.
    - Good water.
  - Treatment
    - Temperament should be studied.
    - Kindness.
    - Regularity and efficiency in milking ; times milked.
  - Health
    - Maintained by sound breeding, feeding, sanitation, and wise and efficient treatment.
    - Healthy digestion ; sound teats and udder.

Breeding from the heifer before she has reached a safe degree of development and maturity retards and may permanently injure her future for milk and breeding. In Australia this error is one of the chief weaknesses of dairy farming. After ten years of age the cow degenerates for breeding, and consequently the same value should not in average cases be placed on her progeny. The age of the bull is also too important to be overlooked; from eight to ten years old he should be discarded. A system of registering bulls for service is not impracticable.

B. Yield	Breed -	Sire. Dam. Maternity
	Food	Water content of food. Abundant supply of water readily accessible.
	Treatment	Temperament should be studied. Kindness. Regularity and efficiency of milking; times milked.
	Health	Maintained by sound breeding, feeding, sanitation, and wise and efficient treatment. Healthy digestion; sound teats and udder.

In a series of experiments which the writer conducted it was shown that cows of inherited milking qualities will suffer less during a period of scanty feeding than cows that are not true to a recognised dairy breed. In other words, inferior cows go off their milk sooner under adverse conditions of feeding, and the flow of milk is less likely to return to its normal condition when the supply of food becomes abundant. It therefore follows that the inferior cow depends more on a regular food supply to produce her "maximum" yield of milk than the better bred dairy cow. In countries that are subject to drought this is more apparent, and where there is a predominance of inferior cows very heavy deficits follow.

Cows might be classed into those of temporary milking qualities and those of permanent qualities.

Season of calving has an influence on the milk yield of cows. If, for example, they come into profit in early winter, instead of the spring, the summer production is increased and the profit for the year is distinctly higher. In Denmark and Sweden this has been proved, and in the United States of America the same conclusion has been arrived at by practical authorities in dairying.

In this book there is no necessity to deal further with the subject beyond a comment on the systems of testing that are in use in different countries.

Babcock Test.—In New Zealand, Australia, and Canada the Babcock test is used in at least 98 per cent. of the factories. The apparatus is simple in construction, easy to work, comparatively cheap, and the cost of upkeep is an important feature in its favour, while the test is thoroughly effective for the purposes it was intended by the great American chemist whose name it bears. For testing cream the "Babcock" is eminently suited, and where factories have a large number of samples to handle time is a consideration. The use of the apparatus for dairy farmers is strongly recommended, as the simplicity of the outfit and the ease in testing milk brings it within the province of every practical man. The accompanying illustration shows the writer at work in 1898 when he inaugurated a campaign in Australia in the testing of cows on the farm for milk and market. The illustration will further serve to show to the reader that there is nothing complex in the apparatus, as has been asserted by persons opposed to its use, and who in all probability have had little or no experience of the test.

Gerber Test.—This is also a very useful apparatus for determining the fat content of milk or cream, and it is popular in Britain amongst students of dairying. The cost of the glassware required by the Gerber is somewhat high, and where many breakages occur the expenses amount at the end of the year to quite a considerable sum. Perhaps more time is taken in the manipulation of tests by the Gerber machine, and the somewhat complex nature of the glassware makes washing a question of

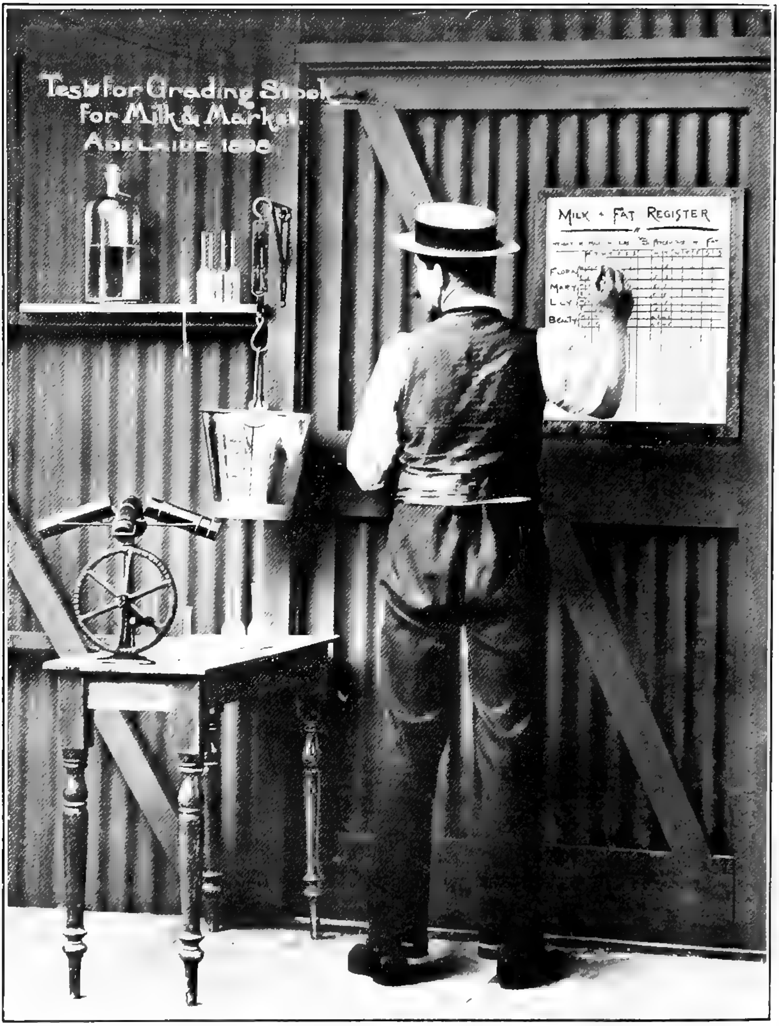


FIG. 54. Demonstrating the Value of Milk Records.

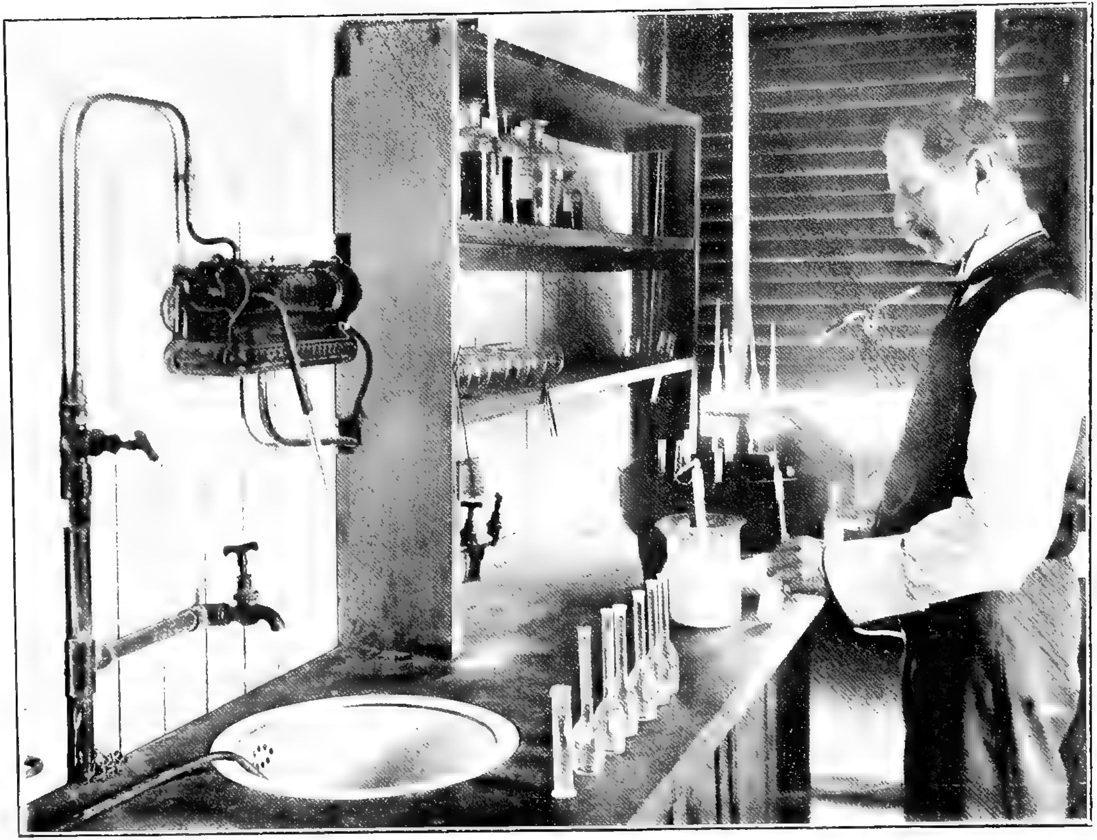


Fig. 55.—Milk and Cream Testing at the Department of Agriculture, Queensland.

very great care, otherwise the accuracy of tests would be endangered. The weighing of the samples of cream by the Gerber system is to be recommended, and where the work is entrusted to trustworthy and thoroughly competent employees, the additional time required for the operation is well repaid.

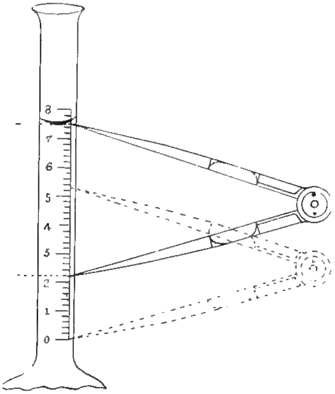


FIG. 56.—Measuring the Fat in the Babcock Test by the Compass. This very simple and accurate method is recommended to prevent errors common to other practices (Thomson).

Russian Test.—The writer has also had considerable experience of this test, and excellent results are obtained by it, but there are features of the glassware which offer some objection compared with the very simple and durable bottles used in the Babcock test. The Russian machine was at one time commonly used in Queensland factories, but of recent years it has been entirely replaced by the Babcock.

Government Supervision of the Dairying Industry

A dairying Act has a terrifying effect on some people. This should not be, if we conduct our dairies, milk shops, and factories in obeyance to sanitary laws and the rules of good trading. When we neglect to exercise our duty we become a danger to the community. And that is not the only injustice inflicted. An injury is perpetrated on those who are carrying out voluntarily all that practical legislation would insist upon. It is a serious reflection when the intelligent, painstaking, and industrious employees of the dairying industry are made to suffer for the misdeeds of the careless. In the supply of milk the public are the referees, but as already stated in some countries no monetary distinction is made between dirty and clean milk, wholesome and impure, and poor and rich milk —for each the same price is paid. It, therefore, follows that an Act of Parliament is absolutely necessary to right what is wrong, by making every person associated with dairying do his share in keeping the milk and cream supply up to a standard of cleanliness, purity, and quality. A sound, practical Act of Parliament would also be a direct encouragement to dairying and dairy farming, and it would give the public confidence in the industry, thereby increasing the demand for the products of the farm. Those embarking in dairying for the first time would have the advantage of beginning life on a sound foundation, thus escaping the perennial difficulties, dangers, and worries associated with improper methods. The status of the whole industry would be raised, and every man put on an equal footing. Education would be guided along the proper channels by a Dairy Act, to the benefit of all concerned.

Practical and theoretical education and legislation should go hand in hand, the former to train those upon whom the giving of advice devolves, and the latter to put it into practice. It is quite within the possibility of legislation unsupported by a system of education to mould the dairying industry of a country and guide it successfully, but it is not in accordance with fact for education alone to succeed in establishing dairying on a sound and healthy footing. When the dairying industry of Queensland was brought under legislation, it was mooted in some quarters that compulsion would destroy the very existence of the small producer. The opposite has happened, for legislation has been the chief instrument in raising Queensland dairying from a state of chaos to the most successful in the Commonwealth, as official reports and statistics will prove. New South Wales, the mother State of Australia, and Queensland's neighbour, with her more extensive scientific system of instruction, has not progressed as educational enthusiasts anticipated, which proves the fallacy of any country placing the future of dairying entirely in the hands of the teacher.

Dairying legislation, therefore, is not an experiment: we have further evidence of its tremendous worth in Denmark, Switzerland, New Zealand, and Canada. Queensland is the youngest country in the Empire to have revolutionised dairying by legislation. The writer had the honour of preparing the State for its Dairy Acts, and in putting the technical provisions into operation. The experience and knowledge gained in this direction have been most helpful in the preparation of this book.

The following extracts from the Queensland Dairy Acts of 1904 and 1905 will prove interesting:—

QUEENSLAND DAIRY ACTS

Interpretation of Terms. "Conveyance" includes every description of cart, waggon, truck, or other vehicle;

"Dairy" includes land, premises, and buildings used in connection with the production of milk, and also any premises where cream is separated for the purpose of being supplied to a factory;

"Dairy-House" Any place or room used in a dairy as a separator room, milk room, or room for the storage of dairy produce;

"Dairy Produce"—Milk, cream, butter, cheese, condensed milk, or any other product of milk or cream;

"Factory"—Any building or place where butter, cheese, or condensed milk is prepared or manufactured;

"Milk-shop"—Any building or place or any stall or vehicle in which milk is sold or exposed or offered for sale by retail, and is the only or principal product so retailed;

"Owner"—The owner, whether jointly or severally; the term includes the owner's agent or manager; and in the case of a company, the manager, secretary, or other principal officer thereof; when applied to premises, the term includes the person having the charge, management, or control of the same;

"Pure Milk"—The whole of the milk, including the strippings drawn at the time of milking; the term does not include milk which contains less than 3 per cent. of butter fat or less than 8.5 per cent. of solids other than butter fat, or is mixed with any preservative or chemical or colouring matter of any kind whatsoever;

"Separated Milk"—Milk of whole milk after the cream has been separated, and which does not contain any added preservative or colouring matter;

Inspectors and Inspection.—No inspector shall, by himself or his partners, have any interest directly or indirectly in any factory, dairy, or milk-shop, or any place where dairy produce is dealt with or sold, or in any trade or business connected therewith. Every inspector who violates this provision shall be dismissed by the Minister, and shall be disqualified for reappointment.

Premises used as a dairy or factory or milk-shop shall be registered under this Act.

The inspector may deliver or send any sample of dairy produce or water to an expert for examination, and the expert shall upon receipt of the sample, with all convenient speed, examine the same, and give to the inspector a certificate of the result of the examination in the form in the Second Schedule to this Act, or to the like effect.

If after inspection an inspector is satisfied that—

Any dairy or factory or milk-shop is in an unclean or unwholesome condition; or

Any utensil, machinery, apparatus, or work at a dairy or factory or milk-shop is in an unclean or unwholesome condition, or is otherwise unfit for the purposes of dairy produce; or

Any stock at a dairy are diseased; or

Any person is afflicted with disease so that any dairy produce is likely to be contaminated: or

The water used in connection with a dairy is impure or unwholesome; or

Any cooling chamber or inconvenience used for the storage or carriage of dairy produce is in an unclean or unwholesome condition, or is otherwise unfit for the purposes of dairy produce;

He may, by order in writing under his hand, addressed to the owner of the dairy or factory or milk-shop, or of the cooling chamber or conveyance, or to the consigner of the dairy produce, as the case may be, without further name or description:

Order compliance with the Act.

Every separator-room, milk-room, and room used for the storage of dairy produce shall be well ventilated, and so constructed as to be capable of thorough cleansing. It shall not be used for any other purpose than that of storing dairy produce and utensils. Every such room shall be limewashed or otherwise treated with approved disinfectant at least once in every four months.

Every creamery and factory shall have impervious water-tight floors, shall be well ventilated and effectively drained, and shall be thoroughly disinfected as often as may be prescribed.

Every cheese-making room or maturing room shall be well ventilated. All whey shall be forthwith removed to a distance therefrom of at least one hundred feet, or shall be sterilised by steam or rendered innocuous by proper treatment in an approved septic tank, or by such other means as may be prescribed.

No person shall keep pigs in styes, or place or use any manure heap within a distance of one hundred and fifty feet from any dairy-house or factory, or erect or use any place as a dairy-house or factory within a distance of one hundred and fifty feet from any piggery, manure heap, or offensive stagnant water.

No person shall place or use any fowl-house within fifty feet from any dairy-house or factory, or erect or use any place as a dairy-house or factory within a distance of fifty feet from any fowl-house.

No cesspit shall be permitted to exist upon any dairy, and no factory shall be placed within one hundred and fifty feet from any cesspit.

No person shall permit any drainage from any piggery or stockyard to lie or flow within a distance of one hundred and fifty feet from any dairy-house or factory unless in a drain properly cemented.

No dairy produce intended for sale or supply for profit shall be deposited or kept in any room used for domestic purposes, or in any place which might cause such produce to be unwholesome or injurious to health, or in any place where goods or other materials likely to taint such produce or contaminate it with disease are kept or permitted to lie.

No person shall sell or supply—

Any dairy produce condemned by an inspector ;

Any milk or cream which is unfit for the food of man ;

Any milk or the cream from any milk which has been drawn from a cow that is known to or suspected by such person to be diseased, or that has been isolated in pursuance of this Act, or that has calved within six clear days before the day on which the milk was drawn from her ;

Any condensed milk which contains less than 9 per cent. of butter fat, and 24 per cent. of solids other than butter fat, unless it is sold or supplied as condensed separated milk, and every package containing it, whether sold or supplied wholesale or retail, is marked "condensed separated milk" in capital letters not less than half an inch square.

Cleansing of Utensils.—The separator bowl, and all parts of the separator which come in contact with milk, shall be thoroughly cleansed on each occasion immediately after the process of separating, first by immersion in cold water, and then cleansed by steam or hot water. All dry utensils shall be properly cleansed in the same manner.

All utensils received at a factory or dairy containing milk or cream shall, before being sent away from such dairy or factory, be cleansed by cold water, and then by steam or boiling water, and, where practicable, thoroughly aired. Before clean utensils received from the factory or dairy are filled with milk or cream, they should be rinsed out with clean water and aired.

Position of Sanitary Conveniences.—No earth closet or other sanitary convenience shall be placed within fifty feet of any separator room, milk room, or room used for the storage of dairy produce.

Situation of Piggeries and Sanitary Conveniences.—No milking shed shall be placed within one hundred and fifty feet from any piggery, earth closet, or cesspit.

The Construction of Milking-Sheds.—Milking-sheds shall be so constructed that, unless the inspector otherwise approves, calves shall not be housed under the same roof as that which covers the milking pails or stands.

The Disinfection of Milking Sheds.—All milking sheds shall be limewashed once at least in every six months.

Cleansing Udders.—At the time of milking, the udders and teats shall be thoroughly cleansed, and the hands of the person employed in milking shall be thoroughly clean.

Standard of Cream.—(*a*) The minimum standard of butter fat in cream is hereby prescribed to be thirty-five per cent.

(*b*) Every owner of a factory shall, when required, furnish to a cream inspector a list of his cream suppliers, with particulars of the percentages of butter fat in the various deliveries of cream.

(*c*) Cream supplied to owners of factories and cream depots shall, from time to time, be inspected by a cream inspector. The cost of such inspection shall be defrayed by the owners of factories in the manner following, that is to say:—Every owner of a factory shall pay to the Under Secretary for Agriculture and Stock a sum equal to one penny for each one hundred pounds of butter manufactured by him. Such payments shall be made during the months of January and July in each year.

(*d*) If a cream inspector finds that the cream supplied by any supplier contains less than the prescribed percentage of butter fat, he shall, upon a subsequent delivery of cream by such supplier, take samples in triplicate of the cream, and, after marking the samples for identification, shall hand or send one sample to the supplier, and one sample to the owner of the factory, and shall forward for analysis the remaining sample to the Under Secretary for Agriculture and Stock.

(*e*) Before a sample of cream is taken by an inspector for analysis, or by an inspector or other person for testing in respect of butter fat, the cream shall be tipped into a clean can, and afterwards returned to the original can, and then thoroughly mixed by means of a plunger approved by the inspector. The sample shall be taken by means of a tube approved by the inspector.

Qualifications for Testing Cream and Milk.—On and after the first day of May 1906, no person shall be employed in the testing of cream and milk until he has passed a practical examination in testing, and has obtained a certificate of proficiency signed by the Minister.

State Supervision of Dairy Glassware

In enforcing the technical branch of the Act dealing with the 35 per cent. fat standard, and the testing of cream, the writer had many reasons for complaint against the inferior and defective glassware that was in use. Upon close inquiry into the subject, it was found to be more serious than was at first anticipated. To the milk and cream-tester, butter and cheese-maker, inaccurate thermometers and testing apparatus is a serious handicap, and this was fully demonstrated at the close of the inquiry. A regulation under the Dairy Act was accordingly passed stipulating what alterations were necessary in the design and manufacture of glassware for dairies, and no person was allowed to sell thermometers or glassware used in testing dairy produce until the same were examined, standarised, and stamped by the Department of Agriculture. This regulation has proved most helpful to the industry.

Compulsory Grading of Cream.

Encouraged by the success that followed the fat standard, and the testing of cream by those holding official certificates of proficiency, the Government was induced to make the grading of cream compulsory throughout the State. This decision was based upon exhaustive inquiries into every phase of butter production, and there are very sound reasons for saying that in the absence of legislation affecting the cream supply, no country where the farm separator is extensively used will produce butter of a thoroughly reliable quality. The gist of the practical investigations which led to the compulsory grading of cream are given in Chapters II. and III., and there readers will find sufficient evidence to show that grading should only be intrusted to thoroughly competent and qualified men.

Butter Grading

Queensland is the only State in the Commonwealth where the classification of export butter and cheese is compulsory. After several years' experience of the system which the writer established, the State has had good cause to pronounce a favourable decision on the educational and commercial value of butter grading. Further reference is made to the subject in this work, and in "Milk and Cream Testing" it is fully dealt with.

Are the Acts too Severe?

After a perusal of the chief features of the Queensland Act, one might be tempted to ask himself the question —Are the provisions too drastic? This view will readily appeal to the British dairyman who lives under different conditions of climate, etc., but the principle of the Act will apply equally to all countries.

Administration of Act

When common sense and discretion are exercised in the administration of a practical Dairy Act, no hardship or injustice need fall upon the farmer. Time is given to remedy evils, and as suggested in this work, Government advice and instruction should be provided to help the farmer to comply with the law to the best advantage. The success of an Act depends upon the administration, and, no matter how perfect a measure may be, if badly enforced, failures are inevitable.

The Queensland Dairy Acts were administered on a helpful basis. All the inspectors were appointed after a competitive examination, and every precaution was exercised to prevent none other than competent men from receiving appointments. These Government officers were eminently practical, having a sound knowledge of dairying and dairy farming, the needs of the producer, and how they were best to be met without unnecessary cost, hardship, or inconvenience. The dairying districts of the State were divided into sections, and each was under the supervision of an inspector. His duties were to instruct and advise farmers on dairy matters coming within the sphere of the Acts, and at the same time, carry out the requirements of the law. The inspectors were directly responsible to the Department of Agriculture. When the farmers realised that the inspectors were not police officers, and knew their business, the success of dairy legislation in Queensland was assured.

COMMONWEALTH COMMERCE ACT

Recent additional regulations under the Australian Commonwealth Act are as under:—

"Butter which contains any fat other than butter fat, any preservatives other than boracic acid, any colouring matter unless viewed by the minister to be harmless, or contains more than 16 per cent. water, or 3 per cent. casein, or 4 per cent. salt, or ½ per cent. boric acid, or less than 82 per cent. butter fat, will be unlawful."

CANADIAN PROVISIONS

The following are abstracts from a bulletin prepared by the Canadian Dairy Commissioner, also from an American copy of legislation regulations applying to the manufacture and disposal of renovated or process butter:—

Canadian Laws in Relation to Butter.—For commercial purposes butter is divided into two grades, namely, "Dairy" and "Creamery." It is provided in the Inspection and Sale Act that no person shall:—

(*a*) Manufacture or import into Canada, or offer, sell, or have in his possession for sale any butter containing over sixteen per cent. of water.

(*b*) Mix with butter any acid, alkali, chemical, or any substance whatever, which is introduced or used for the purpose or with the effect of causing the butter to absorb water or any part of milk or cream.

(*c*) Manufacture, import into Canada, or offer, sell, or have in his possession for sale, any oleomargarine, butterine, or other substitute for butter, manufactured wholly or in part from any fat other than that of milk or cream.

(*d*) Manufacture, import into Canada, or offer, sell, expose, or have in his possession for sale, any renovated or process butter.

Canadian Laws Relating to both Butter and Cheese.—(1) All cheese and butter made in Canada destined for export shall have the word "Canadian," "Canadien," or "Canada" marked on the packages.

(2) No person shall apply any brand, stamp, or mark of the word "Canadian," "Canadien," or "Canada," as a descriptive term on any cheese, or upon any box or package which contains cheese or butter, unless such cheese or butter has been produced in Canada.

(3) No person shall knowingly sell, or offer, expose, or have in his possession for sale, any cheese or butter upon which, or upon any box or package containing which is printed, stamped, or marked, any month other than the month in which such cheese or butter was made.

(4) No person shall supply to a cheese factory, creamery, or condensed milk factory any milk which has been skimmed or adulterated in any way.

AMERICAN LAWS

Butter Classes.—The United States Government has found it necessary to divide butter into three classes—first, second, and third—for the better enforcement of the Act.

Class 1 must be butter made exclusively from milk or cream, or both, with or without common salt, or with or without colouring matter.

Class 2 is subdivided into three grades. The first describes reworked or renovated butter to which any substance has been added; the second applies to butter cheapened in price by admixtures; the third to abnormal quantities of moistures, etc., contained in the butter (so-called emulsified or milk-blended butter).

Class 3 is defined as process or renovated butter—a grade which has been subjected to any process of melting, clarifying, or refining, and made to resemble genuine butter.

Adulterated Butter.—Adulterated butter is defined to mean a grade of butter produced by mixing, reworking, rechurning, refining, or in any way producing a uniform, purified, or improved product from butters that have been treated for rancidity, melted, etc. Process or renovated butters come under this class, also butters that are rechurned in milk or cream, which in Britain is termed milk-blended butter. A valuable feature of the United States dairying legislation is in connection with the water standard of butter. The Act reads thus :—

"It is therefore held that butter having 16 per cent. or more of moisture contains an abnormal quantity, and is classed as adulterated butter."

In Britain milk-blended butter may contain 25 per cent. of water without the product coming under the law of adulteration.

Creamery Butter.—The owners of factories of genuine creamery butter are not subject to special taxes.

Renovated or Process Butter.—On the Continent the practice of purifying butter is extensively followed. In England it is done on a small scale, but the "happy hunting ground" for renovating butter is the United States of America. There it is a huge trade practised by all classes, who reap great fortunes from the business. In the States legislation has recently been enacted to safeguard the public against dangers arising from the manufacture of renovated butter. The following regulations are taken from the Act :—

1. All churns, melting tanks, workers, cans, vats, blowing tanks, settling tanks, trucks, trays, and other receptacles, chutes, platforms, racks, tables, and all utensils, machinery, and other equipment used in preparing, moving, cutting, chopping, and in otherwise handling the materials used in the manufacture of renovated or process butter, and in all processes of manufacture of renovated or process butter or its preparation for market, shall be kept clean and sanitary.

2. Managers of renovated butter factories shall require employees to be cleanly. Aprons, smocks, and other outer clothing worn by employees who handle or in any way come in contact with the renovated or process butter shall be of material that is readily cleaned and made sanitary, and only clean garments shall be worn. All persons who handle renovated or process butter or any material entering into the manufacture of same shall be required to keep their hands clean, and they shall be required

also to pay particular attention to the cleanliness of their boots and shoes.

3. Due care must be taken to prevent renovated or process butter, in any stage of its manufacture, from falling on the floor, and in the event of its having so fallen, the soiled portion shall be removed and condemned. Oil or grease collected from floors, drains, or catch basins shall not be used in the manufacture of renovated or process butter.

4. Air used in blowing or aerating the oil during the process of manufacture shall be pure and clean, and shall be taken from the outside of the building; and in order to prevent the use of air which is contaminated with dust, smoke, objectionable odours, etc., some approved method of purification, such as washing or filtering through cotton, shall be provided.

Oleomargarine.—The manufacture of margarine and butter substitutes is a very extensive business in the United States of America. It has been found necessary to pass special legislation to put the trade on an honest and safe footing. The following is an outline of some important features of the Acts.

Separate Factory for each Product.—If the manufacturer of oleomargarine is also engaged in the manufacture of adulterated butter, process or renovated butter, the buildings must be separated from each other by solid walls or partitions, and such premises cannot be used for the handling or manipulation of butter that is not taxed under the Act of 9th May 1902.

Government Records.—Every manufacturer of oleomargarine is required to enter daily in a book the quantity of materials used for the production of oleomargarine, the number of packages and pounds of oleomargarine produced, the number of packages and pounds of oleomargarine sold or removed, and the name and the place of business or residence of each person to whom the margarine is sold or consigned.

This book or form must always be kept at the factory, and be always open to the inspection of any internal revenue officer or agent.

If the manufacturer is also a retail dealer, he will enter sales to himself giving all details, as if they were made to any other retail dealer.

All transactions must be entered in the order of time in which they occur, the records as to one day's business being completed before those of the next day are commenced.

Taxes. -The law imposes a tax of 10 cents a lb. on oleomargarine artificially coloured in imitation of butter, and one-fourth of 1 cent per lb. on uncoloured oleomargarine. On adulterated butter 10 cents per lb. are also paid, and on process or renovated butter one-fourth of a cent per pound.

In addition to the above, special taxes are levied as follows :—

Manufacturers of oleomargarine	$600
Wholesale dealers in oleomargarine coloured artificially to look like butter	480
Wholesale dealers in oleomargarine not artificially coloured, only -	200
Retail dealers in oleomargarine coloured artificially to look like butter	48
Retail dealers in oleomargarine not artificially coloured, only	6
Manufacturers of adulterated butter	600
Wholesale dealers in adulterated butter	480
Retail dealers in adulterated butter	48
Manufacturers of process or renovated butter	50

The law also specifies that :—

> "Any person who sells, vends, or furnishes oleomargarine for the use or consumption of others, except to his own family table, without compensation, who shall add to or mix with such oleomargarine any artificial coloration that causes it to look like butter of any shade of yellow, shall also be held to be a manufacturer of oleomargarine within the meaning of said Act, and subject to the provisions thereof."

Fines.—"That every person who carries on the business of a manufacturer of oleomargarine without having paid the special tax therefor, as required by law, shall, besides being liable to the payment of the tax, be fined not less than 1,000, and not more than 5,000 dollars."

From the American Revised Regulations concerning Oleomargarine. Microscope as a Test for Oleomargarine.

"The difference between fresh, genuine, unmelted butter and oleomargarine can be readily detected by a microscope with the aid of polarised light.

"Butter which has been melted or renovated sometimes shows crystals under polarised light, but one who has had experience in the use of the microscope will rarely be misled by this fact.

"A microscope is furnished to collectors of internal revenue suitable for use by local officers in the field."

Description of Microscope.—"The instrument consists first of a large bell-shaped base and tube attached to this base, into which tube fits another or draw tube, containing at the outer end an eye-piece, at the inner end an objective, and between the eye-piece and objective is a Nicol's prism or analyser. There is a second Nicol's prism or polariser, which is to be attached to the base after the focus has been obtained."

Method of Using the Microscope.—"The instrument will be used in the following manner: With the point of a pen-knife place a small portion of the fresh sample taken from the inside of the mass on the middle of one of the glass slides; place a cover on it; press the cover firmly down on the slide with the blunt end of a pencil, care being taken to make the object sufficiently translucent, and insert the slide, with cover towards objective, in the slot prepared for it in the mouth of the instrument; press each end of the glass slide down gently, and turn it slightly so that the corners will be held in place by the spring pressing against the back of the base, care being taken to get the object in front of the objective; pull out the draw-tube about three-fourths of an inch, and look through the instrument held towards the direct light from a window or a gas or lamp flame placed within a short distance; slide the tube slowly in or out until the object is sharply defined; then attach the polariser to the base, and, holding the instrument toward the light, rotate the lens (which is provided with a milled head for the purpose) until the field of view is dark. If melted fats are present, the field will be illuminated with bright white particles; if not, it will be uniformly dark.

"Where nothing is seen but the characteristic globules, the granular masses of curd and the cubicle crystals of salt, even when the polariser is turned so that the field is lightest, the sample can at once be passed as genuine butter.

"When there is any doubt whatever in regard to the results of the microscopic examination of a suspected sample, it should be remitted to the Commissioner of Internal Revenue for a thorough chemical analysis. This should also be done where legal proceedings are likely to be based upon the character of the sample, as a chemical analysis will afford more conclusive proof than the microscopic test."

Swiss Laws

The following is a translation of the more important provisions:—

Milk must be treated with the greatest care and cleanliness in milking, storing, and in the transport and sale. Milk which becomes dirty from standing must not be offered for sale. All fresh milk when offered for sale must not exceed a fixed acidity.

Milk, which is faulty in smell, taste, or colour is forbidden for sale; also milk up to eight days after calving. Milk which shows a sediment in standing, and from cows suffering from a disease which would endanger the health of consumers, or from cows that have been treated with medicines which affect milk, such as turpentine, arsenic, mercury, must not be offered for sale, also the sale of milk containing preservatives is forbidden.

When milk is found not to conform with regulations, a sample from the cow must, if possible, be procured on the following day, or within three days from the taking of the first sample from the mixed milk of the same cows. In cases where the supply is from not more than two cows, additional samples must be taken within eight days from the first sample.

When the sample does not reach the official standard, the seller is strongly warned, and the inspector is justified to forbid further sale of the milk.

Sellers are compelled to stir the milk thoroughly in the transport and sale casks.

Utensils used for milking, transport, storing, and measuring must not be of lead, zinc, galvanised iron, or untinned copper, and shall be of material and shape to ensure thorough and easy cleansing. The same shall be kept in good repair, and may not be used for any other purpose. This regulation also applies to utensils used in the transport of milk. No evil-smelling goods shall accompany full or empty milk cans.

Rooms for the sale of milk must be kept clean, and must be spacious, well ventilated, cool, and they must not be used as living or sleeping apartments. In the same room only articles which do not injure the quality of milk or contaminate the atmosphere may be kept.

Persons suffering from an infectious disease must not be employed for milking, or have any connection with the dairy.

Pasteurised, sterilised, or humanised milk must be so specified, and must contain no preservatives.

Skim or separated milk must only be carried in special cans bearing the word "skim milk" in letters at least 5 cm. high, distinct and not easily obliterated. The milk shall contain at least 8.5 per cent. of solids.

Cream shall contain at least 15 per cent. fat. The addition of preservatives, colouring, or thickening substances are prohibited.

Kephir and similar products must only be made from cooked or pasteurised milk.

Milk preparations must state whether made from whole or skim milk, and must contain no preservatives with the exception of sugar.

DANISH LAWS

In 1911 butter laws were brought about by co-operation between Danish commerce and Danish agriculture to raise and protect the reputation of agricultural exports. They are being carried out in conjunction with previous dairy laws. It is now anticipated that Danish dairy legislation is about perfect.

In accordance with the law it is forbidden to export from Denmark butter which contains more than 16 per cent. of water or other preservative than salt. Further, it is forbidden to export butter coloured with aniline dye, and to export milk and cream, unless same have been heated to a temperature of at least 80° C. Danish butter must not be exported from the country unless manufactured from pasteurised (heated to at least 80° C.) milk or cream, and only from controlled dairies, and the product has to be marked at the place of manufacture with a trade-mark authorised by the Danish Minister of Agriculture.

A feature of very great importance in the 1911 laws is the prominence and protection that is given to a national trade-mark for butter called the "Lur" brand. In future this brand will be the hall-mark of quality for the whole of Denmark. The Government will insist that all factories entitled to use this brand will have complied with numerous conditions and stipulations necessary to the butter attaining a high standard of quality, and any breach of the law in this direction may prohibit the use of the brand, thereby causing serious injury to the factory or company. To safeguard the brand, the Minister of Agriculture is entrusted with great powers. Australia and other countries might with profit consider this law.

EXTRACTS FROM NETHERLANDS BUTTER ACT, 1908

Section 3.—"It is prohibited to supply, to keep in a shop or any other public selling place, to publicly expose for sale, to distribute, to hawk, to transport, to import or to export, to have in store ready for transport or export, margarine which, in determining the neutralising figure of the volatile fatty acids in 5 grms. of the melted and filtered fat, indicates a Reichert-Wollny number higher than 10."

Section 7.—"In case the margarine is kept in a shop or any other selling place open to the public, or is publicly exposed for sale, the word 'margarine' shall be clearly visible to all persons visiting such places or to the public.

"When margarine is kept in a shop or in any other selling place open to the public and used for the sale of this merchandise, or for the sale of both butter and margarine, the word 'margarine' shall be posted up conspicuously above the door or doors giving access to such selling place, and also on the windows which are closest to both sides of these doors. The words shop and selling place in the present and following sections shall include the spaces in front of such premises used for exposing the merchandise.

"Inscriptions similar to and placed in the same manner as those referred to in the foregoing paragraph are compulsory for places where margarine is manufactured, and also for the warehouses and similar buildings where margarine is stored by margarine manufacturers or dealers."

Section 10.—"Where butter and margarine are kept in the same shop or any other selling place open to the public, the latter merchandise shall be placed in a separate part of such premises, or shall be separated from the butter by a partition clearly visible to the purchasers. In addition to this, a board must be placed above the margarine in accordance with the provisions of the fourth paragraph of section 7. Where butter and margarine are kept in a market or similar selling place open to the public, the butter and margarine placed in the same stall shall be separated by a partition clearly visible to the purchasers."

Section 12.—"If, in case an offence is committed under section 3, 7, or 10, or under the first or second paragraph of section 11 of this Act, two years have not yet elapsed since a previous conviction of the offender for a violation of one of those provisions, has become unappealable, or the fine imposed has been paid, such person shall not be allowed, unless specially authorised by the Minister, to keep both margarine or butter in the same shop or other public selling place, or in the same market, stall, or similar place for exposing goods for sale."

Section 13.—"The detection of offences under this Act is entrusted to officers who will bear the title of Government dairy inspectors, assistant Government dairy inspectors, and Government dairy examiners. A similar duty is conferred upon the officers referred to in section 8, subsections 1 to 6, of the Criminal Code, upon the country police and upon all other members of the Government and Municipal police forces, except when the merchandise is being forwarded by public conveyance or warehoused for transport or export in buildings or depots kept for such purpose.

"Honorary Government dairy examiners can be appointed.

Such officers shall also be entrusted with the duties mentioned in the first paragraph of this section."

Section 21.—"A person committing an offence under section 2 or 3, knowing that the merchandise concerned does not fulfil the requirements provided in or in accordance with the said sections, shall be liable to imprisonment for a period not exceeding one year."

Section 24.—"If, at the time when an offence under this Act is committed, two years have not yet elapsed since a previous conviction under this Act of the same offender has become unappealable, or the imposed fine has been paid, the judgment shall include an order for publication, on the expenses of the offender, of the judgment or of the material portion thereof."

Section 25.—"The offences which are made punishable under section 21 shall be considered as crimes; those which are made punishable under section 22 as contraventions."

CHAPTER VI

BACTERIOLOGY, CALCULATIONS, MILK PREPARATIONS, AND ANALYSES

In looking back to the days of Pasteur, who laid the foundation of bacteriology, and successfully crushed Leibig's theory of spontaneous generation, we can note its progress. No industry is more closely associated and dependent upon the influences of bacteria than dairying, and no better field is open to the scientist than the produce of the dairy. Dairy bacteriology is of great magnitude, and every year additions are made to the already extensive literature.

It is a very fascinating science for the student, and the practical dairyman should take a greater interest in the subject. He should understand the functions of bacteria, the conditions under which they exist, and their usefulness and dangers. The writer will make an effort to explain these important elements, and to illustrate useful and hurtful bacteria.

The bacteria of milk may be classed in the following order:–

1. Producers of good and bad acids.
2. Proteid-digesting bacteria.
3. Gas producers.
4. "Fibrous bacteria."
5. Pathogenic.
6. Unclassed bacteria.

We have also moulds and yeasts. Some are of the highest value to the cheese-maker, others are hurtful. Useful moulds and bacteria must have all that is necessary to a healthy life before the best results can be obtained, and this the manufacturer has to study in making different varieties of cheese. Some moulds require more air than others, and this class operates from the outside of the cheese: examples—Camembert, Brie. Others work throughout the entire body of the cheese, as in Stilton, Gorgonzola, and Roquefort. Each variety of cheese also has its special bacteria. In cheddars we have the lactic organism, and it may be said they play a part in the flavouring and maturing of all cheeses. The qualities in Edam cheese largely depend upon a streptococcus called Hollandicus, which is sometimes confounded with the stringy organisms usually met with in dirty dairies; and in Gruyère the bacillus diatrypeticus is credited with producing the holes which is a feature of the cheese. In the Cantal cheese of Italy the "tyrothrix" bacteria are essential to the successful manufacture of this variety.

Bacteria are the smallest known living organisms, and can only be examined when brought under a strong magnifying power. Bacteria are included in the vegetable kingdom, resembling the algæ, possessing no green matter.

Structure.—Owing to their minuteness, it is difficult for scientists to give an accurate description of their parts. The outer covering constitutes the skin or membrane; the inner part contains a substance known as protoplasm or living matter.

Shape.—The shape varies with the different species. The bacterium is short and rod shaped; bacillus (plural bacilli) is of moderate length; spirillum (plural spirillæ) is of corkscrew appearance.

They are found singly, in pairs, in chains, and in bunches, and to each is given a technical name. Other forms have whip-like bodies to facilitate locomotion.

Reproduction.—Bacteria principally multiply in two ways; first, by splitting. The microbe elongates itself, and then divides into two independent bodies able to reproduce themselves. Their rate of multiplying under favourable conditions is extraordinary. Assuming one single germ divides into two in one hour, four in two hours, eight in three hours, at the end of twenty-four hours the increase would be very great. The other way of reproduction is by the formation of small bodies called spores.

Having a stronger membrane, spores can withstand conditions fatal to non-spore forming bacteria. Spores are of two kinds –internal spores (endogenous), and joint spores (anthrospores). In the bacillus the protoplasm changes into contractile bodies bursting the membrane, and the liberated spores afterwards develop into new bacilli. In joint spores a cell or little egg appears at the end of the bacillus, gets detached, and changes into a spore. With suitable conditions this spore germinates into a fully-developed plant. Those resistible bacteria readily assume the above form when danger threatens them, as when food and moisture are scarce, when temperature is too high or too low, and when poisons are present. Unfortunately for the dairying industry, spores can remain for a lengthened period in a dormant state, and await favourable conditions to develop.

How Germs Find an Entrance.—The want of a practical knowledge of the causes of injurious changes in milk and cream is one of the reasons why dairymen and factory employees neglect to enforce preventive means of reducing the risks of contamination. It may be argued: "What can dairymen do to the keeping quality of milk before it leaves the farm?" The answer is re-echoed throughout this book: "Keep out foreign matter, and have every place in a sound sanitary condition." The practical mind will be better convinced of the existence and danger of germ life by reference to the bacteriological illustrations. Photographs were taken from specimens in actual growth. The presence of organisms which comprise the colonies seen in the plates account for the heavy losses sustained by the industry. It is to be hoped that farmers and factory managers will take precautions to carry out the advice given in these chapters, and make their dairy buildings and factories an object lesson of cleanliness.

Conditions Influencing the Development of Bacteria.—A highly suitable medium for the multiplication of bacteria is milk, which possesses in a soluble and available form the essential food for their maintenance and reproduction. Most bacteria require oxygen, carbon, water, and mineral salt; also many require a nitrogenous diet. Temperature is important, about 95° F., or the temperature of freshly-drawn milk, being found most favourable. The principal forms we have to deal with in milk and cream require air, and are called aerobic; some found in the heart of cheese and butter, and living without air, are called anaerobic, and the butyric spore-forming bacteria may be cited as an example. There are also what are termed obligate and facultative aerobic and anaerobic ferments. For example, the bacillus of symptomatic anthrax and lockjaw can only live in the complete absence of oxygen; therefore they are obligate anaerobic, and those classed as facultative aerobic can survive for a long time without oxygen.

Where Injurious Germs are Found.—Practically speaking, micro-organisms are found wherever organic matter exists. Different species impart to our produce special offensive flavours. Some are not detrimental when kept in check, being otherwise useful in what they manufacture, but they prepare the way for other organisms that are productive of taint. These organisms find a suitable environment in unsanitary milking-yards, on the teats and udder of the cow, in milk-rooms, in factories, and in utensils which are not effectively cleansed and scalded. They accompany the particles of dirt in enormous numbers, and multiply with such rapidity that a can of milk will suffer in flavour in less than one hour.

Cultivation of Germs.—In many respects bacteria are like the higher plants, they develop more perfectly and rapidly when grown in certain foods, and when kept under certain conditions of temperature. The principal food used in these illustrations is known as agar, which is prepared from Japanese seaweed. Germs are sown in this substance, and nothing more than heat and air are required to make their growth (colonies) visible to the naked eye. Their appearance is well brought out in the photographs of plates and tubes given in this chapter.

Sowing the Organisms.—In preparing for the examination of milk, cream, butter, or water, the first step is to sterilise the glass plate. A tube containing congealed agar is melted by heat and cooled to a certain temperature. A speck of the substance to be examined is added to the agar, and the tube is well shaken to distribute the germs. The contents of the tube is poured into the plate, a glass cover is placed over it, and is then removed to an incubator and kept at a suitable temperature. In the examination of air the culture media (germ food) is poured into the plate, after which it is ready for exposure.

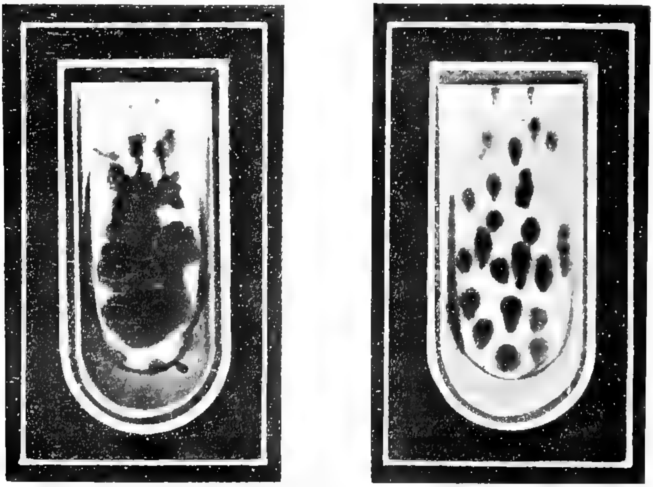


FIG. 57. Cultures from Hands of Milker (Thomson).

Acid Milk.—The word "contamination" is not used scientifically with reference to acid milk. In cheddar cheese-making and butter-making a degree of acidity is essential to the manufacture of good produce, but it frequently happens that acid milk and cream are not free from taint.

The following experiment was conducted to show the value of care and aeration in the treatment of milk. At a dairy farm a cow was milked in a careful manner, and at the close of the operation the milk was aerated by means of a common cooler, and run into a can that had been previously scalded and cooled down. Immediately after aeration the can was covered with a damp muslin cloth and removed to a clean and warm dairy, where the milk was allowed to become acid. To show that injurious germs were not abundant in milk treated in such a beneficial way, a plate culture was made and the colonies microscopically examined. They all belonged to the lactic acid group which flourish in ripe milk and cream, and from what has been written readers will now fully understand that they largely contribute to the good flavours of butter and cheese. To give an illustration of an opposite kind, a quantity of milk was taken from a supplier's can on a Monday morning; the milk was not acid to the taste, although it was otherwise unpleasant. A plate culture was prepared from the milk, with the result shown in Fig. 59. Mould will be seen in this illustration, which shows that milk is a carrier of this fungus to the cream, butter, and cheese, and the tube cultures bear out this contention.

Cream.—The question of cream interests the butter-maker most, as the quality of the butter which he manufactures depends upon the bacteriological purity of the cream. It must not be forgotten that the value of cream is greatly dependent upon the purity of milk, and that tainted milk cannot produce ripe cream of a fine and delicate aroma.

Sterilised Acid and Tainted Cream.—When cream is carefully collected and ripened the acid-producing organisms take possession of the cream and kill others of a hurtful kind. In Denmark over 98 per cent. of the factories pasteurise the cream, and add pure cultures of germs to produce ripeness. By this method the Danes have obtained uniformity in the general quality of their butter, and to this they owe much for their renowned position in the home markets. Milk for cheese-making is also artificially ripened, and the results have fully justified the use of starters.

Plates have been prepared from cream carefully ripened with a culture. The colonies were examined, and no trace of any injurious organism was found. When cream is separated into one can twice daily, and this continued for a number of days, no longer will there be a predominance of the ripening organisms which inhabit every clean and well-kept dairy, but many injurious ones will make their presence known by producing a taint.

Cultures were made from samples of cream obtained from factories that complained of the tainted condition of the cream. The result showed that taint-producing organisms were present in large numbers.

Unsanitary Milk Rooms. -Places used for the storage of milk and cream very often have an abundance of dirt in the air. When cans are left unprotected the dirt and moulds fall into the milk or cream with injurious effects. Separation and cream-ripening are frequently done in the same room, and often the place is utilised for the storing of general lumber as well as meat and vegetables.

A plate of culture media (Fig. 58) was exposed to the air of a badly-kept room for ten minutes. Colonies of germs and mould in wavy lines are seen in the illustration. It will be readily gathered how easy it is for butter to become affected with moulds, also cheese, when such conditions are permitted to exist in our dairies.

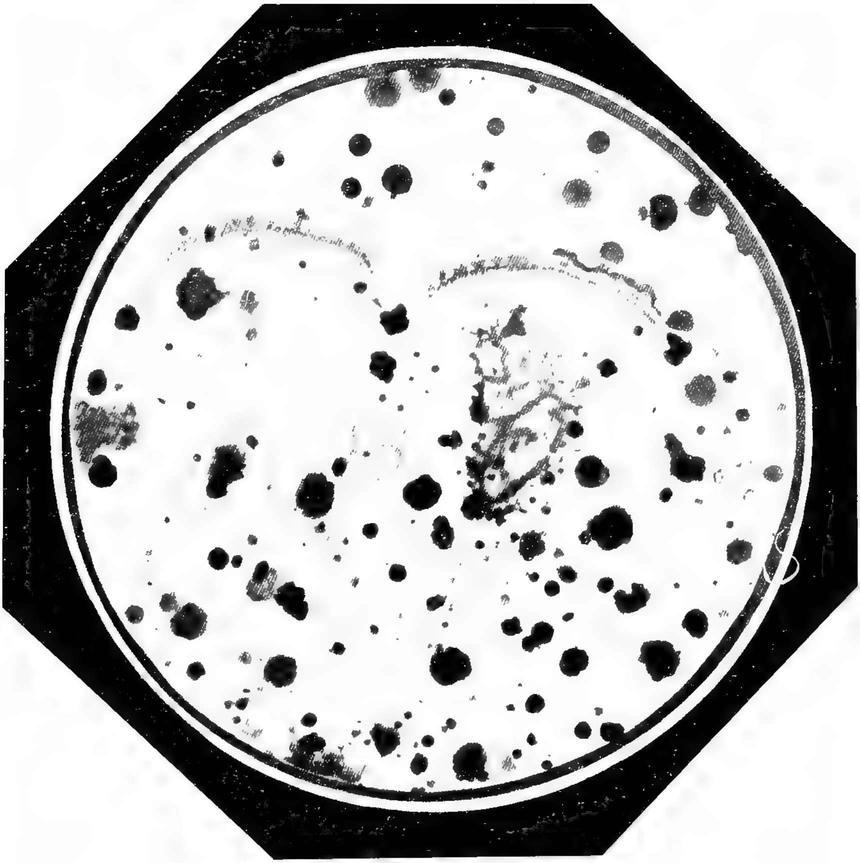


FIG. 58.—From Contaminated Air in Milk and Cream Room. Exposure of plate, 10 minutes. This is a source of injury to all classes of dairy produce. *Odium lactis* and other moulds are illustrated in the plate, and the writer has shown that they can flourish in dairy products heavily preserved with acid preparations. Bacteria and moulds producing various colours were amongst the cultivations obtained in the above illustration. Other exposures were made to determine the influence of the air of cowhouses on the flavour and keeping properties of butter. Plate cultures showed to what extent the atmosphere and produce may be contaminated. The milking machine, however, should overcome dangers of this kind.

Note.—The illustrations appearing in these pages are taken from a report of an investigation which was conducted by the author for the South Australian Government in 1898-1900, and from which certain dairy reforms in Australia eminated. The balance of the illustrations will be found in "Milk and Cream Testing."

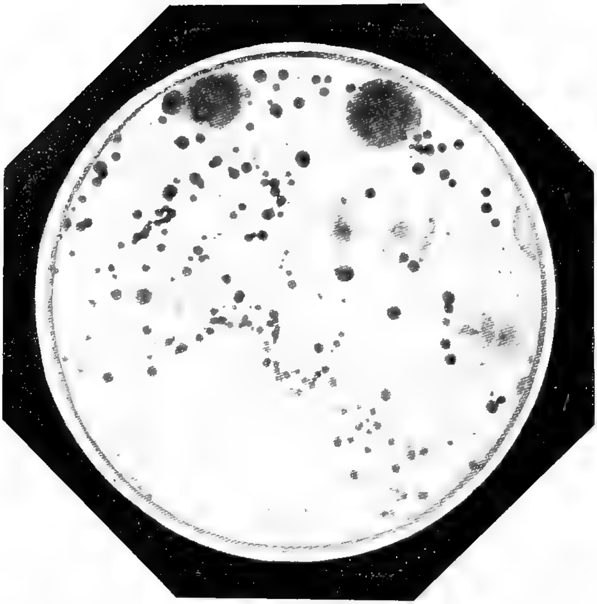


FIG. 59.—Milk Contaminated with Moulds and Injurious Bacteria (Thomson).

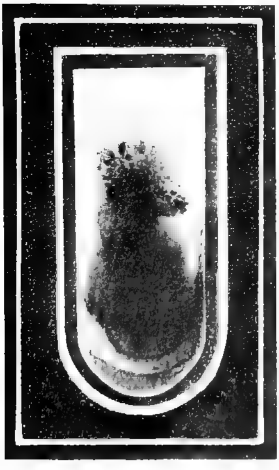


FIG. 60. Smear Culture from Cream showing Mould (Thomson).

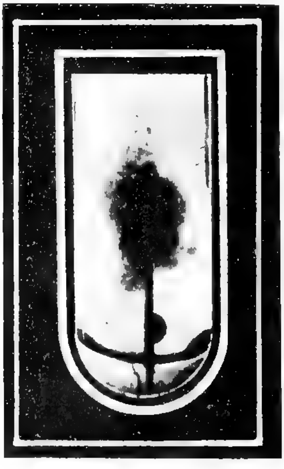


FIG. 61.—Slab Culture from Butter made from Cream (60). Moulds are abundant. As expected, the butter was very rancid (Thomson).

Cultivations of mould were made from milk which was exposed to the air in a dairy; cream was inoculated with it, and the product churned. In the butter the mould was found to be extensively distributed.

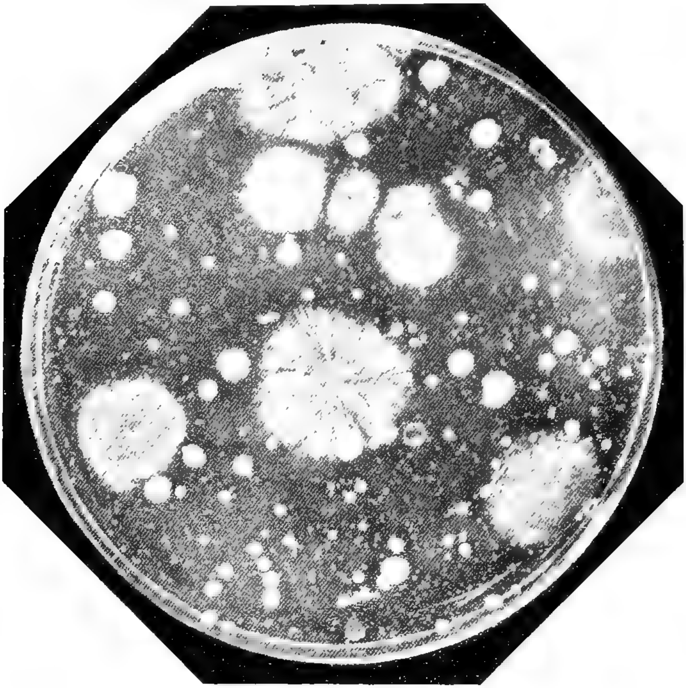


FIG. 62.—Cultivation of Moulds and Bacteria from the Heart of a Cheddar Cheese (Thomson).

AN EXAMPLE OF CONTAMINATION OF PRODUCE

Many striking illustrations could be given to show that very severe losses have been suffered by dairymen, factory proprietors, and others through the ravages of bacteria. Most of the losses could have been prevented had ordinary care been exercised. The following instance is given:—

Contamination by Flies.—A city dairyman who had a very large milk round, particularly amongst professional people and the better-class customers, found that his business was being ruined through what he termed spontaneous coagulation of the milk. The writer had occasion to investigate the defect, and after an extended inquiry it was discovered that flies took an active part in the coagulation, and were thus the enemies of the dairyman. An examination of the dairy showed numerous flies on the milk that was set for cream. As the cream rose a bitter flavour was detected, and this developed with the setting.

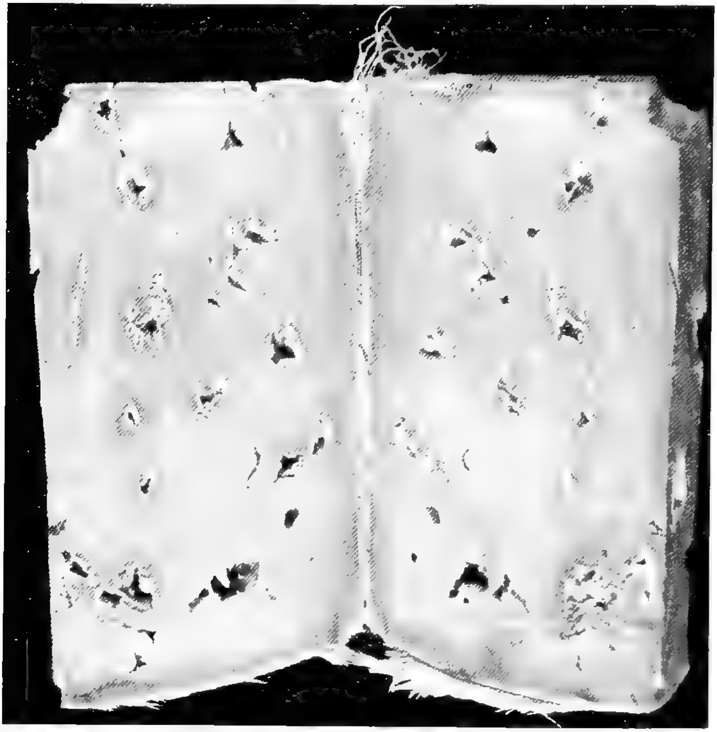


FIG. 63.—Showing Cheddar Cheese badly affected with Moulds (Thomson).

Bacteriological examinations of the bodies of the flies revealed organisms similar to those discovered in the milk, and inoculations of fresh and sterilised milk with cultivations from their wings and legs reproduced the condition complained of. After close observance the insects were found to frequent a bin of brewers' grains, carrying away with them yeast, and they also gathered additional matter of a dangerous kind from refuse and sewage heaps which were in close proximity to the dairy. Contact of the milk and utensils with the germ-laden flies, and heavy feeding of the cows with brewers' grains, caused the bitter flavour in the cream and the sudden coagulation of the milk.

Dairy Calculations

To the farmer, butter and cheese-maker, some knowledge of dairy calculations is necessary, and the following will be found of value :—

If a herd of twenty dairy Shorthorn cows give a yearly average of 600 gals. of milk with 3.8 per cent. butter fat, and a herd of Jersey (twenty) cows give an average of 450 gals. with 4.2 per cent. butter fat, from which herd would we expect to obtain the most butter, and what quantity of milk in each case would be required to make 1 lb. of butter? First deduct $\frac{1}{4}$ per cent. butter fat for loss in separation and butter-making. Pure butter contains about 86 per cent. fat. If 86 lb. fat give 100 lb. butter, what will 3.55 lb. fat give?

No. 1. $86 : 3.55 :: 100 : x.$

$x = 4.13$ approx.

$100 : 12{,}000$ lb. $:: 4.13 : x.$

$x = 495.60$ lb. of butter.

No. 2. $86 : 3.95 :: 100 \quad x.$

$x = 4.59$ approx.

then $100 : 9{,}000 :: 4.59 \quad x.$

$x = 413.10$ lb. of butter.

Difference in favour of first herd = 82.50 lb.

To find the quantity of milk required to make 1 lb. of butter. If 12,000 gals. produce 5,114 lb. of butter, how much milk is required to make 1 lb. of butter?

1st 5,114 1 :: 12,000 $x = 2.3$ galls.
2nd 4,263 : 1 :: 9,000 : $x = 2.1$,,

Given 50 gals. of milk at a temperature of 80° F. If 10 gals. are taken out, what temperature must it be heated to to bring the whole body of milk to 84° F. Multiply the number of gals. by the difference in temperature, divide by the number of gals. taken out, and add to the first temperature. Thus:—

$$\frac{50 \times 4}{10} + 80 = 100^\circ \text{ F.}$$

How many gals. at 120 F. is required to raise the temperature of 50 gals. from 80° to 85° F.?

$$\frac{50 \times 5}{120 \times 80} = \frac{250}{40} = 6\tfrac{1}{4} \text{ gals.}$$

If 50 gals. of milk are removed from 100 gals. at 90° F., what temperature must it be reduced to to bring the bulk of milk to 85° F.?

$$\frac{100 \times 5}{50} = 10 - 85 = 75.$$

Separator.—In separating milk numerous authentic tests have been made by manufacturers to prove the efficiency of the machines. These trials have shown that less than 0.1 of 1 per cent. of fat is left in the separator milk, but we find where defects exist heavy losses to factories result. In "Milk and Cream Testing" this subject is detailed at considerable length, and it is therefore not intended to deal with it here.

Where milk is separated in large quantities, as we find in many of our factories, depots, or even at the farm, the separator milk should be tested for fat frequently. We will take the following as an example of loss of fat:—

If the separator leaves 0.2 of 1 per cent. of fat in the milk, the loss of the extra 0.1 on say 500 gals. will amount to $\frac{1}{2}$ lb. of fat. As pure butter contains 86 per cent. of fat, equal to 1 lb. of fat in 1.16 lb. of butter, what quantity of butter will $\frac{1}{2}$ lb. of fat represent?

Thus:—$1 : 0.5 :: 1.16 = 0.580$ lb.

Taking 0.580 lb. of butter as the daily loss on 500 gals. of milk, and the average price of butter at 1s. per lb., the yearly loss on 300 working days will amount to £8. 14s. What, then, must the waste of money be in establishments treating thousands of gallons per day?

The same calculation should be applied to butter-making and to cheese-making. In the former case, when 0.5 of 1 per cent. of fat above the average tests is left in the buttermilk, the loss in an average-sized factory would not be less than £100 a year.

Calculations to find the proper churning temperature of cream are very misleading. Too much depends upon conditions that have no relationship to arithmetic.

Purchase of Milk on a Quality Basis.—Milk used to be bought according to its measurement and creamometer reading. By this system accuracy was impossible. The Weighbridge and the Babcock tests are now relied upon for correct results. The same applies to cream. By the use of a chart, the price to be paid is at once ascertained.

To Find the Fat Content of Cream.—Subtract the fat percentage of the separator milk from the fat content of the whole milk and multiply by 100. Divide by the percentage of cream skimmed and the answer will give the approximate percentage of fat in the cream. Follow these directions and divide by the percentage of fat in the cream and the percentage of cream skimmed will be ascertained.

There may be a fascination in arithmetic of this kind, but the best of results are got by the Babcock testing of the cream. Graduated bottles for cream can be purchased for either the Babcock or the Gerber testers, and the tests are thoroughly reliable for all practical purposes. In the same machine and at one operation the Babcock tester will determine the fat percentages of whole milk, separator milk, buttermilk, and cream, duplicate bottles in each case being used to balance the machine, and for accuracy in testing.

This system obviates unbusinesslike calculations, and puts the testing of dairy products on an indisputable basis, giving justice and satisfaction to all parties.

Milk Preparations

The research scholar should go abroad and study milk preparations and their effects on consumers. Very valuable information would be obtained from the peasantry in Russia and near Eastern countries. Nature seems to have taught races in these parts of the world to take precautionary measures in the treatment of milk which, in more advanced agricultural countries, have been the outcome of scientific discovery. It therefore follows that the research scholar abroad would be in a position to find the most demonstrative evidence to assist him in arriving at conclusions of great worth in the investigations he may be conducting. The writer again suggests that seats of learning should exchange their most promising students with those of other countries who have been granted scholarships in agricultural research.

The writer has carefully observed how native specialists in the Balkans prepare milk dishes, and conclusive evidence has been given of the wonderful curative and health-giving properties of the preparations. The following is a brief explanation of the making of the commonest dishes and drinks.

(*A.*) Milk is selected that is known to have special qualities for souring. It is put in large shallow dishes in a cool, airy room. A damp muslin is placed over the dishes to keep the milk clean, as the natives would say; also where the room is draughty (which is preferred by some peasants) the muslin checks the cool currents and prevents bitter flavours in the milk. When the milk has developed a sweet acid flavour it is whisked into a foam and then allowed to settle. In this condition it is drank.

(*B.*) The milk is raised to boiling point, and allowed to cool naturally to a temperature of about 80° F., which is usually determined by the finger. A starter from the previous make is added to the milk, and ripening takes place gradually. No attempt is made to interfere with the temperature. When the flavour is found to be satisfactory, the milk is either whisked or drank in the sour condition.

In Russia a preparation called "Prostakvasha" is much partaken of by all classes. The milk is put in a warm atmosphere, and when a certain degree of acidity or ripeness is reached it is removed to a cool room. The coagulated milk is eaten with powdered sugar, grated black bread, and cinnamon. Starters are saved from the choicest flavoured preparations for future use. The more skilled natives are splendid judges of flavour. Peasants will tell you that boiling destroys the healing properties of milk, hence it is necessary to restore this by adding an acid product, or, as it is generally called, a starter.

With reference to the special milk used in (*A*) the writer has gathered the following interesting information from native sources.

Cows must be in full milk, also in good health, and live in the open air. The food must be natural, preferably matured grass. Drinking water must be pure.

These qualifications supply the conditions demanded by the native acid-making bacteria. Cows living in the open air is an important contributing factor to a fine flavour in ripened milk, and the importance of food and water have already been explained.

In English-speaking countries the only milk dish is curds or junket, and buttermilk may be cited as the only milk drink that is in any way allied to the preparations referred to. But this class of milk can only be obtained where butter is manufactured, and its quality will depend upon the conditions that govern the making of high-class butter. This limits the use of buttermilk, but acid milk drinks can be successfully made by the average housewife, and nothing safer and more beneficial can be taken to quench the thirst in hot weather, while in addition the medicinal value is unquestionably high.

Greek National Milk Drink.—The milk of the sheep is largely used in Greece in the preparation of what is known in that country as "Yaourti." Digestive ingredients are taken from the stomach of the "unweaned" lamb, and this is mixed with a small quantity of warm milk to make the starter. The milk to be ripened is concentrated by heat. It is then placed in small dishes. When the albumin has congealed on the surface of the milk, 15 to 20 drops of the starter are very carefully put under the skin. "Yaourti" is ripened in an atmosphere of from 70-75 F., and takes from six to eight hours. The dishes are kept warm by the use of woollen covers or blankets.

Russian Koumis.—In healing, the influence of the mind no doubt is a potent factor. A sick person who makes up his mind that he is going to get well by seeking a change of air, food, and perhaps a change of medicine is likely to succeed. Worthless drugs may also "cure" if the mind is made up that the preparations possess great healing properties. Advertising may, therefore, be linked with curative medicine, but with preventive medicine it can only be classed as an antagonist.

If people benefit by drinking coloured and flavoured water, the "treatment" is more likely to be effective if the medicine is natural and genuine. Milk preparations as a cure for illness are not advertised. Koumis, sour milk, the water of fermented cabbage and other vegetables, are "medicines" that are fully partaken of in Russia and other European countries.

It was Dr Carrick who brought koumis prominently under the notice of British medical men some twenty-five years ago. After he had studied the effects of the drink on sufferers from consumption, diabetes, anæmia, and other complaints, he founded, in 1899, a hospital and farm at Orenburg on the Asiatic frontier of Russia. There Dr Carrick did a great work, but unfortunately it has not been thoroughly appreciated. In fact, many of the late Dr Carrick's medical associates in this country refused to listen intelligently to the story of the achievements in lonely Orenburg of that courageous and gifted Scotsman.

Dr Carrick was years in advance of his time, and for which he suffered. Since his death, the hospital and farm have been carried on by his nephew with wonderful success.

Koumis as a Cure for Consumption.—The Russian drink is made from the milk of the mare. A particular breed has been found by experience to produce a quality of milk that gives a special fermentation; also the atmosphere is a powerful element in giving to koumis properties of the highest value. This bears out the writer's views with regard to ripening bacteria.

It therefore follows that the breed of mares is an important factor, and with a dry air in summer and winter, koumis of the highest medicinal value is produced. The same condition of climate is necessary to the health of the patient. Where the atmosphere is dry and the rainfall sparse, the natural forage is matured, and this in turn supplies the milk with constituents which no doubt favour a choice product.

Preparation of Koumis.—Scrupulous cleanliness is first of all necessary. Koumis is made in four qualities, according to the time given to fermentation, which varies from ten to forty-eight hours.

As mares' milk contains a high percentage of sugar, as subjoined analysis show, a fair proportion of alcohol is produced, and when skilfully made koumis has an attractive champagne flavour, and may be distinctly "heady."

	Percentage Composition.
Water	90.80.
Fat	1.30.
Proteids	1.80.
Sugar	5.80.

To the fresh milk is added a starter from a previous making of strong koumis. The liquid is then stirred for fifteen minutes, and this is repeated for some minutes every hour for twelve hours. It is allowed to ferment, the hours of fermentation, as above stated, decide the grades.

Patients drink as many as ten champagne bottles of koumis per day, and in the hot summer weather this may be exceeded with increased benefit. Koumis has a sharpening effect on the appetite, and is comforting to the sleepless.

The principle of koumis treatment consists in reforming the absorbing properties of what one might call the organisms of health, making them more powerful in their struggle with infection.

Why the Mare is Selected.—The consumptive is asked to drink an abundant supply of cow's milk, but it is usually recommended that the cow must be certified as free from tubercular and other diseases. The mare, the sheep, and the goat are not subject to tuberculosis. It therefore follows that the milk of these animals will be better for consumptives than the product of the cow. For this and other very important reasons encouragement should be given in Britain to breed the goat and the sheep for milk.

In Japan consumption is treated very successfully with a preparation the active ingredient of which is the yoke or fat of wool.

Dry Milk.—The methods of preparing dried milk have improved, and the use of the product is now more extensive.

Restrictions are already being placed on its improper use. For adulteration it offers some attractions, but the absorptive properties of the milk are against its sale for such purposes as mixing with milk for cheese-making. The cheeses readily heave when this is done, and they ripen imperfectly. The powder is very useful in hot climates, or where whole milk is difficult to obtain and unhealthy to use.

One of the methods of manufacture is as follows:—Two large cylinders are constructed to rotate, the distance between them being very small. The machine has a similar appearance to the metal rollers used in margarine factories. Milk is delivered between the cylinders, which are internally heated, causing it to immediately solidify on the metal. A scraper automatically removes the dried milk. Owing to the high temperature used, and the suddenness of the drying process, the powder has the advantage of being sterilised, without having more than a faintly cooked flavour.

The difference between the analysis of whole milk and the powdered product may be given as follows.

	Whole Milk.	Dried Milk.
Water	87.5	5.20
Fat	3.5	25.90
Casein	3.5	25.60
Sugar	4.75	36.80
Ash	0.75	6.90
Total	100.00	100.00

Condensed Milk.—The introduction of this industry is the work of French scholars. In 1827 Appert experimented to concentrate milk to half its volume by evaporation, and to this he added the yolk of eggs. Unfortunately the taste of the product displeased, and the experiments were not successful. Later Martin de

Lignac subjected milk to heat, and added 75 grammes of sugar per litre. After reducing the bulk to one-fifth, the condensed milk was put into soldered tins and sterilised at 104° R. To prevent injury to the proteids by boiling, Gallais evaporated the milk in shallow pans, but the product was affected by the air. To obviate this the milk was treated in a vacuum vessel, and the first of improved construction was employed by Gail Borden of New York in 1860. Several years later M. Henri Page founded at Cham, in the neighbourhood of Lucerne, a small factory, which treated, in 1867, the milk of 263 cows, producing 137,000 tins of condensed milk. These works served as the foundation of the famous Anglo-Swiss Company, the largest establishment of its kind in the world.

The manufacture of condensed milk offers no difficulty; it is, in fact, simple, the "secret" of greatest importance being the freedom of the raw milk from bad flavours and unwelcome germs, and to safeguard against injuries of this kind, scalding the milk at the farm is sometimes a stipulation in the purchase contract. On arrival of the milk at the factory, one of the first operations is to reduce the size of the globules by driving the milk with great force against a solid surface, or through a series of tiny holes.

After the acid in the milk has been neutralised by the use of harmless preparations, it is treated in the vacuum pan to a temperature varying from 105-120° F. A large proportion of water is driven off, and to the residue is added sugar, which has a preserving effect on the condensed product.

Unsweetened condensed milk is also produced, and what is known as concentrated milk, a name generally applied to the Australian product, is practically the same as ordinary condensed milk.

Casein Manufacture.—Milk casein is used very extensively for the manufacture of patent foods, celluloid, horn, toilet creams, adhesive compounds, rubbers, paints, cement, and numerous other substances. The demand for the casein is likely to continue, as it is a cheap and healthy substitute for many articles of considerable commercial value as above shown. The process of manufacture is simple, and no expensive plant or elaborate buildings are required. Separated milk is coagulated usually with rennet or weak acids; the whey is drained and the curd washed. It is afterwards stirred with water containing a small proportion of soda, or other alkaline substance, and steamed to remove acids and fats. Upon cooling, the raw casein is again treated with acid, and then thoroughly washed, pressed, and dried at 125-145° F.

Analysis of Dairy Products

The following may be taken as the average composition of the raw, manufactured, and by-products of the dairy. The analysis should be carefully studied, as much information can be obtained from the percentages of the component parts.

MILK

	Per cent.
Water	87.50
Fat -	3.50
Casein and albumen	3.75
Sugar	4.50
Ash	0.75
	100.00

The analysis of milk opens up a wide field of practical and scientific investigation, and dairy students should not be satisfied with committing the percentages to memory; they should turn their attention to the causes of variations in the water content and solids of milk. It is useful to know the relative chemical values of the milk of different breeds of cattle, but it is more useful to thoroughly understand the conditions which influence the milk yield and its quality. These may be repeated as follows:—

Breed of cow.
Temperament.
Treatment.
Milking.
Season and water supply.
Mating period.
Period of lactation.
Health.
Feeding.
Soils.

COLOSTRUM OR "BEASTINGS"

In Chapter III. this subject is reviewed, mention being made of the putrefactive properties of colostrum, and its dangers when used in the manufacture of butter or cheese. In the production of concentrated and condensed milk it may be looked upon as unpardonable to add the milk to normal supplies, so damaging are its properties.

	Per cent.
Water	71.90
Fat	3.00
Casein and albumen	20.70
Sugar	3.30
Mineral matter	1.10
	100.00

COMPOSITION OF CREAM (BELL)

	High Standard.	Low Standard.	Clotted Cream.
	Per cent.	Per cent.	Per cent
Water -	37.62	67.93	33.76
Fat	58.77	24.44	59.79
Sugar	1.46	2.96	1.01
Casein	1.83	4.04	4.97
Ash	0.32	0.63	0.47

Glancing at these figures, and turning to what has been written in previous chapters on the subject of cream and butter making, the reader will more fully appreciate all that has been said in support of a fat standard for cream. In the analysis of the creams of high and low density the latter contains more than double the proportion of casein and sugar. This illustrates that it is very fermentative, while the high standard cream does not contain sufficient food for the ferments to evenly distribute the lactic acid flavour. This quality of cream has, therefore, a higher keeping property.

SHOWING THE RELATIVE FOOD VALUES OF BY-PRODUCTS

	Separated Milk.	Hand-skimmed Milk.	Buttermilk.	Whey.
	Per cent.	Per cent.	Per cent.	Per cent.
Water	91.00	90.10	91.30	93.31
Fat	0.10	0.75	0.40	0.10
Casein -	3.50	3.60	3.40	0.27
Sugar	4.60	4.85	4.00	5.85
Ash	0.80	0.80	0.80	0.47
Totals	100.00	100.00	100.00	100.00

These products are sometimes called the waste of the dairy. It is unnecessary to point out the gravity of the error. Each is a food varying in nutriment, and has a decided value for pigs and poultry. When the extracted fat is supplemented by a cheap digestible oil, separated milk becomes a valuable food for calves. In some parts of Australia and in other countries, calves are exclusively reared on this preparation. When separated milk is sterilised by heat its feeding properties are considerably lowered, and calves thrive badly on the milk, particularly if an oil is not substituted for the cream. Constipation generally follows.

It will be observed that the percentage of fat is highest in hand-skimmed milk, and second in buttermilk; separated milk and whey are equal. The proportion of sugar and casein is highest in hand-skimmed milk, second in separated milk, and lowest in buttermilk. Hand-skimmed milk has, therefore, the highest feeding value, followed by buttermilk and separated milk.

CONDENSED MILK

	Per cent.
Water	25.48
Casein	12.10
Fat	10.80
Milk sugar	13.50
Cane sugar	35.88
Ash	2.24
	100.00

Synthetic Milk.—Recently a product has been put on the market which claims to be of a purely vegetable origin. The manufacturers give the following analysis of the "milk."

	Per cent.
Casein	3·31
Albumoses and peptones	0.15
Other nitrogenous constituents calculated as asparagin	0.24
Fat	3·97
Cane sugar	2.08
Other sugars and soluble carbohydrates	1.70
Mineral constituents (ash)	0.62
Phosphorus, calculated as phosphoric acid (P_2O_5) -	0.17
Water	87.84

The flavour of this product, as judged by the writer, is slightly "biscuity," also a faint acidity can be detected, otherwise it offers nothing really objectionable to the average palate. Time no doubt will eliminate these flavours, and synthetic milk may become a keen rival of the product of the cow. The introduction of this preparation and other imitations of milk should serve as a strong warning to the dairying industry to act promptly, and put the milk and dairy produce business on a healthier and sounder footing.

AVERAGE CHEMICAL ANALYSIS OF BUTTER (FLEISCHMAN)

	Sweet Cream without Salting.		Acid Cream Salted.	
	Unwashed.	Washed.	Unwashed.	Washed.
	Per cent.	Per cent.	Per cent.	Per cent.
Water	15.00	15.00	12.00	12.50
Fat	83.47	83.73	84.75	84.62
Caseous matter	0.60	0.55	0.50	0.48
Other organic matter	0.80	0.60	0.55	0.40
Ash or ash and salt	0.13	0.12	2.20	2.00
	100.00	100.00	100.00	100.00

The salt butter made from ripened cream contains less water, more fat, less caseous and organic matter. The importance of ripening is therefore obvious.

When cows are drying off, and fed on weathered herbage and other dry foods, the water content of butter may fall as low as 7 per cent. and the fat percentage may rise over 90 per cent. The melting point will vary a number of degrees compared with normal butter.

ANALYSIS OF CHEDDAR CHEESE

	Average of Six Analyses.	Eleven Months Old.	Six Months Old.
Water	34.60	30.32	33.92
Fat	31.03	35.53	33.15
Casein	27.60	28.18	28.12
Sugar acid extractions	2.94	1.66	0.96
Salt	1.04	1.55	1.15
Ash	2.79	2.76	2.70
Totals	100.00	100.00	100.00

The loss by shrinkage in Cheddar cheese averages about 8 per cent.

ANALYSIS OF COLONIAL CHEDDAR CHEESE

Brand.	Moisture.	Fat.	Casein.	Salt.	Total Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
A	35.0	33.9	26.3	1.45	4.3
A	34.8	33.0	27.2	1.84	4.6
A	34.6	31.6	27.0	1.65	4.5
B	34.7	32.7	28.5	1.30	3.9
B	34.0	32.7	29.3	0.97	3.6
B	34.4	31.8	27.7	1.28	4.1
C	33.0	33.4	27.4	1.28	3.8
C	30.5	32.7	29.3	0.81	3.4
C	32.0	36.6	28.8	1.47	4.0
D	33.6	33.5	27.7	1.04	3.7
E	32.9	35.1	25.5	1.13	3.6
Average analysis	33.6	33.36	27.7	1.30	4.0

OTHER VARIETIES OF CHEESE

	Water.	Fat.	Casein.	Sugar.	Salt and Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cheshire (matured)	32.60	26.20	32.50	4.45	4.25
Hard Dunlop	37.30	31.80	24.80	3.00	3.40
Pressed skim milk	45.50	9.86	33.20	6.24	5.20
Gruyère	36.90	30.75	27.60	0.20	3.90
Stilton	30.40	36.40	29.20	0.50	3.50
Gorgonzola	44.90	29.80	28.90	0.50	3.80
Camembert	50.50	22.80	21.50	0.30	4.00
Cream cheese	31.00	62.60	5.00	0.20	1.20

ANALYSIS OF RENNET

	Per cent.
Water	78.50
Nitrogenous matter	2.30
Non-nitrogenous matter	0.25
Salt, borax, and other minerals	18.95
	100.00

Commercial rennet contains such preservatives as boracic, salicylic, and benzoic acids. Good rennet is free from any disagreeable smell, and should not be thick or cloudy. Light has a hurtful effect on rennet.

Preservatives.—Boracic acid is the active ingredient in preservatives which are sold to extend the keeping properties of dairy products. The proportion of active borax varies from 90 to 96 per cent., the balance in the preparations being neutral salts.

Salt.—Good salt should have a solubility of 99.5 per cent. For butter-making a fine quality is used; for cheese-making a coarser grain is necessary, otherwise it would be largely lost before the cheese reached the ripening room.

Judging Dairy Produce

Scale of Points

MILK

	Points.
Flavour and odour	70
Body and colour	20
Sediment	10
	100

A more thorough test, demanding a fresh scale of points may be given as follows :—

	Points.
Flavour and odour	50
Sediment and purity test	24
Fat test	16
Body and colour	10
	100

The award for fat would be calculated on the number of degrees above the minimum percentage of 3.2, each percentage being equivalent to 2 points. For example, milk containing 3.4 per cent. of fat would be awarded 4 points, 3.6 per cent., 8 ; 3.8 per cent., 12 ; and 4 per cent., 16 points (see "Purchase and Sale of Milk," p. 26).

CREAM

	Points.
Flavour and odour	60
Body and texture	30
Colour	10
	100

BUTTER

	Points.
Flavour	70
Texture	20
Colour and finish	10
	100

In the face of recent changes in the manufacture of butter, there is a universal want of care in attending to the grain which was so dear to the old school. Taking a broad view of the question, it would appear that we have been guilty of judging produce on too low a scale for flavour, and too high for texture, colour, and finish. It is vitally important to have a good texture in cream, because the butter is the product of the cream, and will betray all its qualities. Also butter is the finished article, but unfortunately the public pay little heed to texture. This puts a higher value on flavour.

In comparing the relationship of texture to flavour, it may be said that the former is governed by five factors, namely, consistency and ripeness of cream, temperature, grain, and working, while flavour has a close relationship to practically every stage in production and manufacture, from the cow and her food to the finished product. We are aware that good flavoured butter with a faulty texture will command a good price, but a bad flavoured butter with a good texture will be a failure. The ratio of texture to flavour might be put as 1 to 3.5, and finish and colour to texture as 1 to 2. Texture must not be confounded with body in describing butter; there is a wide difference between the two terms. Body or character is a quality that is in a sense indigenous to countries, and is chiefly controlled by climate and food. For example, Australian and New Zealand butters possess a body of outstanding merit, while in some other countries a weak body is a characteristic feature, which we shall describe.

CHEDDAR CHEESE

Flavour	60
Texture	30
Colour and finish	10
	100

This variety of cheese is in great demand in Britain, but of recent years there has been a falling off in the consumption of matured cheddars. It is obvious that the public appreciate something new and mild. In this class of cheese we have an "inferior" texture which meets with the approval of consumers, at least no exception is taken to it. Compared with butter, the texture of cheese is of much greater concern. In manufacture and ripening it plays a very important part.

Influence of Shows

The show is an incentive for intelligent and ambitious butter and cheese makers to enter into public competition in a friendly spirit. Much, however, could be done to make shows of dairy produce more educational and instructive. Firstly, only the most competent of men should be appointed to act as judges. Secondly, the object of the show should be protected against inferior produce being included in the prize list. A scale of points might be decided upon as a guide to judges in making awards. For example, 96 to 100 points would be necessary for a first prize ; 93 to 95 for a second, and 90 to 92 for a third, and it should be clearly stated on the show-cards why points have been deducted. Thirdly, an educational stand showing faulty butter and cheese fully described, should be open for sampling purposes. Membership or some other qualification would decide who were to enjoy this privilege.

Butter-Making Competitions

This is purely an exhibition of mechanical skill. The writer does not wish to harm so useful and instructive an object. He himself is a gold medallist in competitive butter-making, but his experience has shown that the value of these demonstrations can be overrated. A candidate might be a prize butter-maker at a competition, and a dismal failure in the manufacture of good commercial butter. It might be suggested that a cream-judging card showing a scale of points should be filled in by each competitor. Correctness or otherwise in grading would be taken into consideration by the judge. Lastly, only men with outstanding qualities as teachers of butter-making should be judges of these competitions ; they are certainly better fitted for the work than amateurs.

CHAPTER VII

DAIRY DEVELOPMENT

Closer Settlement for the Dairy Farmer.—The value of a country depends very largely upon its rural success, and this is governed by the results of those engaged in the various industries embraced in agriculture, which chiefly are sheep farming, cattle breeding, arable and wheat farming, and dairy farming. Might it be asked, Which of the above offers the greatest attraction to the country-bred youth who is bent on an agricultural life? Every man, no matter how intelligent, enterprising, and painstaking he may be, cannot farm on a large scale without capital, and only a small proportion of the rural population possess the necessary funds to follow agriculture as it is practised in England and Scotland to-day. Britain offers attractions for the gentleman of means, but not to the man who may have all the qualities but cash to successfully follow a life on the land. He is, therefore, compelled to take up another calling, or go elsewhere to give effect to his ambitions in agriculture. The future of Canada, Australia, and Africa will be guided by the agriculturist, and the greater the population of farmers the more prosperous and secure will be the country. And these priceless conditions will only be obtained by closer settlement, or small farmers distributed over great areas of fruitful country. Why the writer says "fruitful country," is because he has had experience of closer settlement in different parts of the world, and has seen the danger of dumping people in tracks of country where soil and climate are unfavourable to success. A striking example of this occurred in a British possession, and disaster followed disaster, till eventually the whole colony of settlers were evicted by Nature from their adopted homes.

Again the opposite was shown in a foreign country, where over 100,000 acres of splendid land were subdivided amongst the peasants in farms ranging from 10 to 40 acres, according to the fitness of the peasant to manage the area allotted to him. The farms were worked under the supervision of the Government, and the Agricultural Department supplied the seed and directed the cultivation of the soil, and all important duties associated with the management of the holdings. At the close of each year the peasantry squared their accounts with the Government, and after a fair trial the scheme proved thoroughly successful.

In Great Britain and Ireland, were the opportunities given, dairy farming would have an enormous future for the man of small or moderate capital, for no industry offers a finer combination of attractions. It would give lucrative employment to the husband and wife, and to the family of both sexes.

In Queensland, with a population of 630,000, there are some 10,000 dairy farms, and over 80 butter and cheese factories. Those engaged in the industry in 1911 were responsible for the production of 12,437 tons of butter, and 1,660 tons of cheese. Twenty years ago Queensland was importing nearly 1,000,000 lb. of butter annually for the requirements of the State. A glance at the statistics will show that the output of butter in 1910 exceeded 31,000,000 lb. In 1912, 15,171,074 lb. of butter were exported oversea. The dairy herds of the State numbered 357,095 animals in 1911, of which 237,997 were cows in milk. For a young country this is a promising record.

Why should Britain not produce largely? The country is ready-made, so to speak, for the cow, the climate is favourable all the year round, and the best markets in the world are at the door of every dairying centre. There is nothing to prevent the industry from attaining great

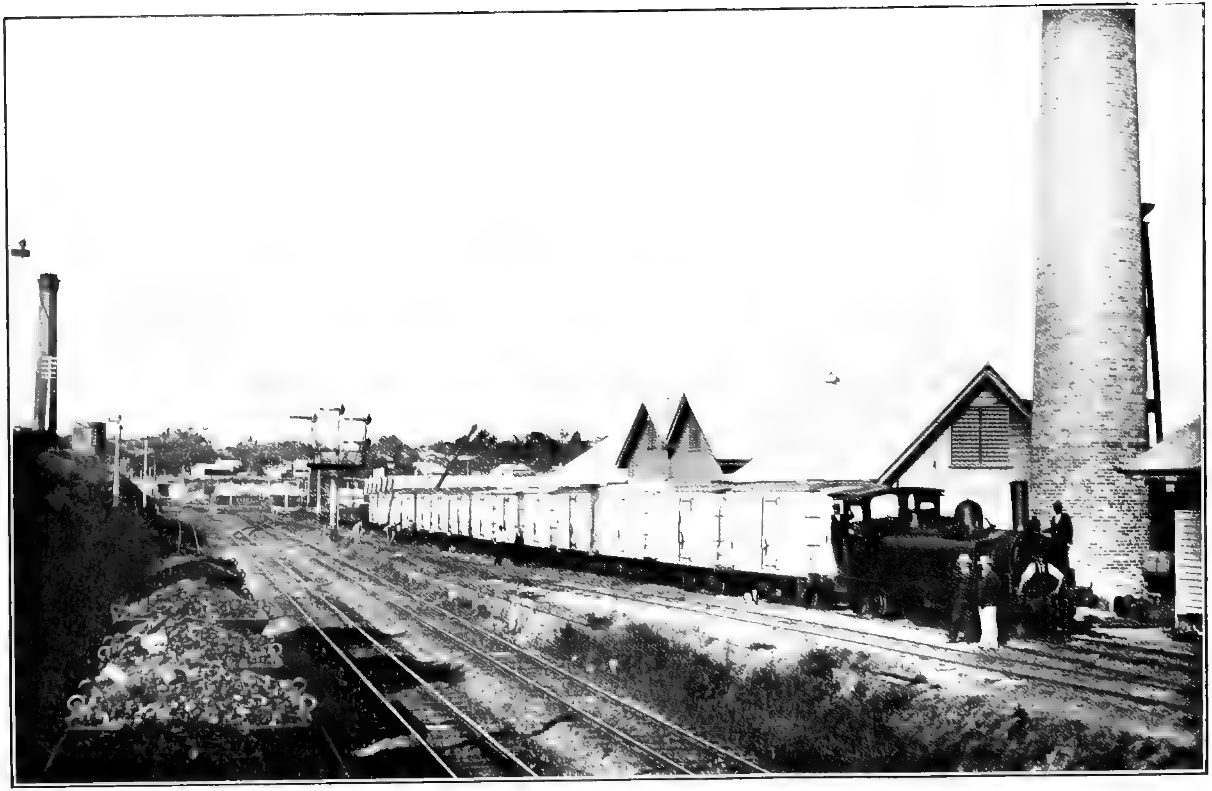


Fig. 64. Butter Train leaving the Government Cool Stores, Roma Street Station, Brisbane (Thomson).

Photo by Dept. Agric. Brisbane.

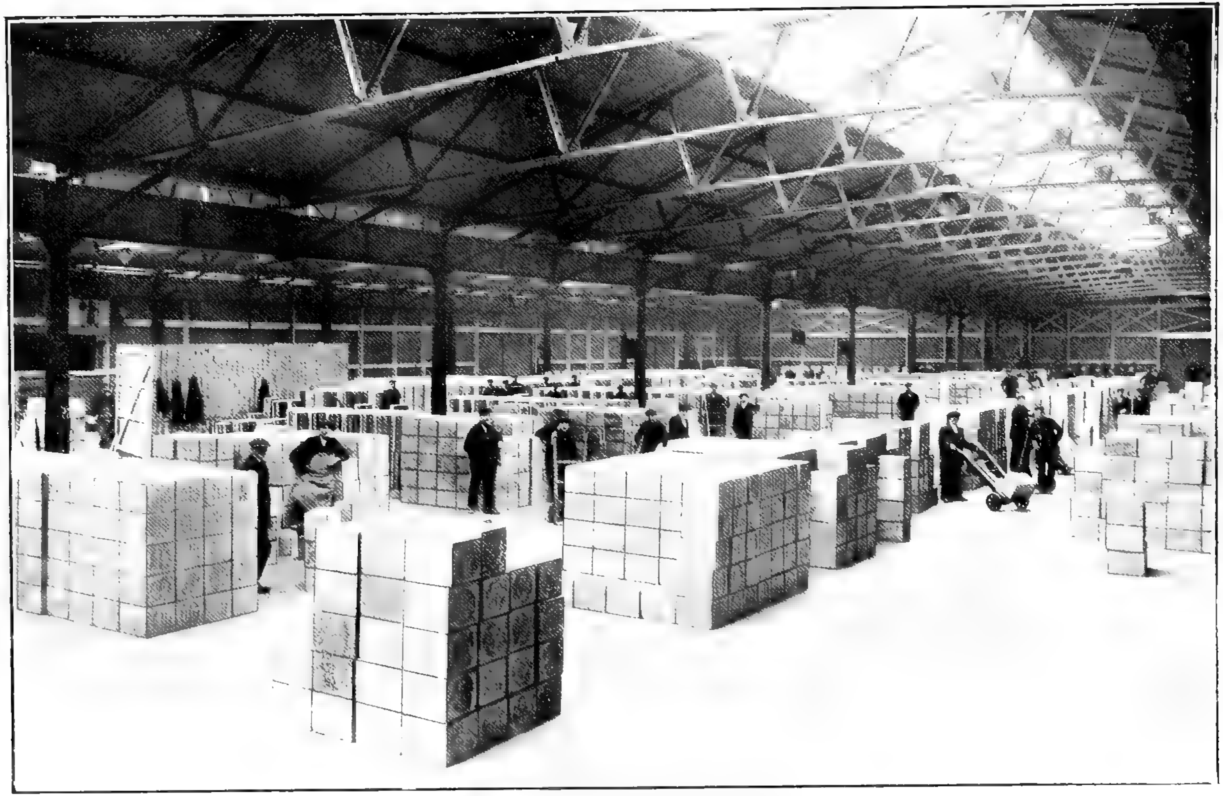


FIG. 65. Inside View of Warehouse at Ship's Side, London.

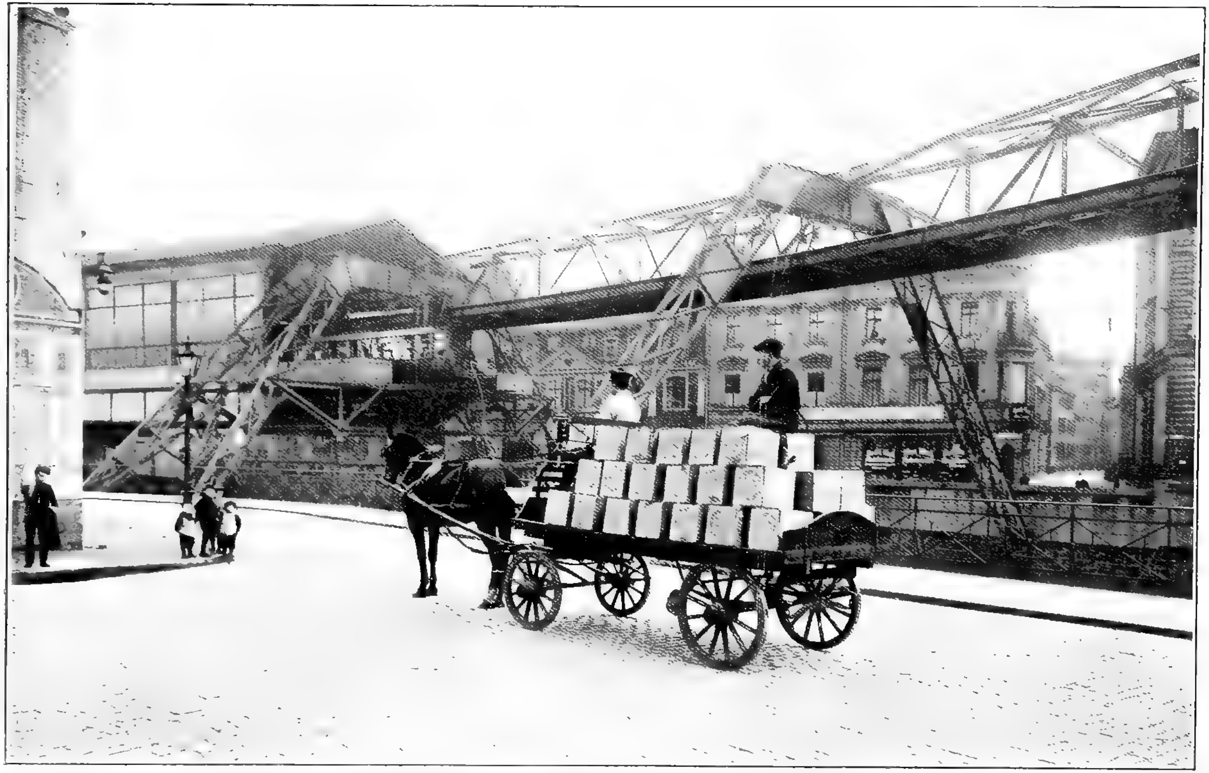


FIG. 66. Elberfeldt Station, Germany, showing Colonial Butter on its Way to Customer's Warehouse.

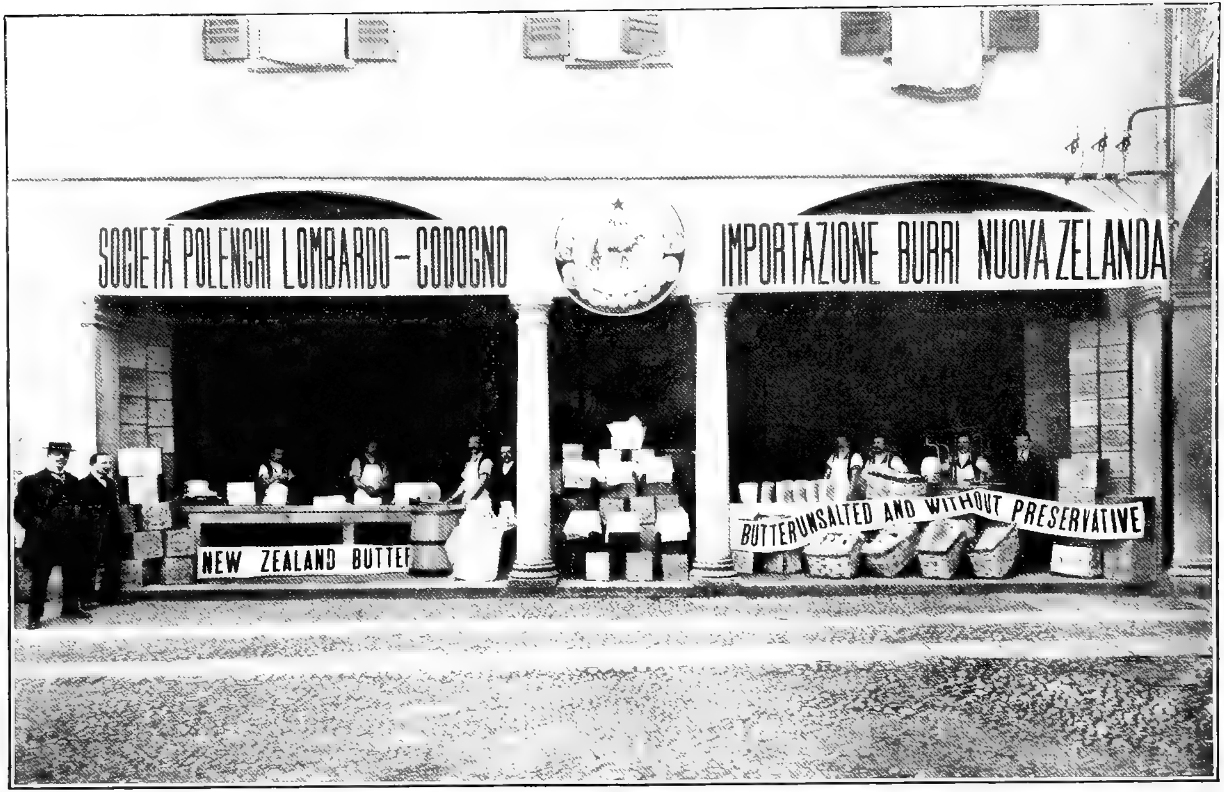

SOCIETÀ POLENGHI LOMBARDO – CODOGNO
IMPORTAZIONE BURRI NUOVA ZELANDA
NEW ZEALAND BUTTER
BUTTER UNSALTED AND WITHOUT PRESERVATIVE

Fig. 67. View of Italian Store at Codogno.

dimensions, and the possibilities for cheese-making alone should give an impetus to this very profitable branch of dairying. The factory system awaits development, and the writer has urged all institutions where dairying is taught to give special attention to this subject. If a thoroughly practical survey is made of the whole question of dairying in Britain, it will be impossible to deny that the country is capable of maintaining hundreds of bacon, butter, cheese, and condensed milk factories, and giving employment to thousands of families who are at present suffering from agricultural depression caused by conditions and circumstances that have been openly encouraged.

Britain as an Exporter of Butter.—Britain is the greatest importer of butter in the world, and it may come as a surprise to many to know that she is also an exporter, as the following figures obtained from an authentic source will show.

During the years 1910, 1911, and 1912, the quantities of butter made in the United Kingdom and exported were 9,244 cwt., 11,928 cwt., and 11,331 cwt. respectively, and the quantities of butter of foreign and colonial origin exported were 68,344 cwt., 135,552 cwt., and 119,031 cwt. respectively.

Development in the Colonies

In Australia, New Zealand, and Canada the manufacture of butter and cheese has assumed gigantic proportions. Australia is rapidly establishing a fair name as a home for the surplus farming population of Britain, and in the report of the Scottish Commission that toured the Commonwealth in 1910-11 we find striking evidence in support of the country for dairy farming in the following extract: "There must be few parts of the world where Nature does so much to help, and so little to hinder, the provident and industrious producer of milk." Australia is a country in which no man with grit should know what it is to want. But to get the quickest benefit as an employee of the great dairying industry, a little practical advice from one with twelve years of experience of the Commonwealth will not be out of place.

The prospective settler should make the best use of his time in the homeland by taking advantage of practical agricultural education, and by applying himself to the work of the farm. A great deal can be learned in Britain that is indispensable in the Colonies, and many err seriously in overlooking this potent fact. The writer contends that a person who decides upon a colonial career, whether as dairy farmer or factory employee, if his time and finance will permit, cannot do better than take a term of tuition at Kilmarnock or one of the English dairy schools, and if instruction at these institutions is combined with a knowledge of dairy farming, it will give the settler a decided advantage over his less fortunate companions. If this is neglected or found impossible, and the person can afford the expense of a course of education at any of the following excellent colleges in Australia—Hawkesbury in New South Wales, Dookie in Victoria, Gatton in Queensland, and Roseworthy in South Australia—time and money will be well repaid. In the six States of the Commonwealth there is a tremendous future for dairy farming, and there is a general attractiveness which makes life a pleasure and a happiness.

Growth of the Industry.—In the past ten years the output of butter in Australia has more than doubled, as the following figures will show. In 1901, 101,671,066 lb. were produced, in 1911 it rose to 212,701,375 lb., valued at over nine and a half million pounds sterling. In the individual States the expansion is indicated by the subjoined figures taken from the Year Book of Australia for 1912.

	New South Wales.	Queensland.	South Australia.	Tasmania.	Victoria.	West Australia.
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
1905	53,040,250	20,319,976	8,226,805	1,281,604	57,606,821	423,270
1906	58,941,137	22,746,593	8,873,632	904,930	68,088,168	380,157
1907	60,041,449	22,789,158	8,519,340	847,860	63,746,354	436,529
1908	61,380,876	23,838,357	8,130,560	3,140,573	48,461,398	365,593
1909	62,865,608	24,592,711	8,482,168	2,751,757	55,166,555	414,453
1910	76,624,830	31,258,333	10,717,486	3,365,982	70,603,787	855,188

The total manufacture of butter in the Commonwealth for 1909-11 is herewith given.

	1909-10.	1910-11.
	Lb.	Lb.
New South Wales	4,775,268	5,191,089
Queensland	3,662,497	4,146,661
South Australia	1,578,378	1,796,281
Tasmania	731,290	868,781
Victoria	5,025,834	4,530,893
Western Australia	1,570	3,306
Total	15,774,837	16,537,011

The export trade in butter and cheese is the chief source of revenue of the dairying industry, and the principal countries supplied are Britain and South Africa. In the near future a good connection may be looked for on the Continent where the possibilities for high-class dairy produce are unquestionably good. The export of butter from 1907-11 and the quantities and values of shipments from the different States in the latter year are as follows :—

	Quantity.	Value.
	Lb.	£
1907	66,076,915	2,890,261
1908	51,193,311	2,386,548
1909	55,644,925	2,399,693
1910	87,899,479	3,951,256
1911	101,730,176	4,637,472
New South Wales	33,083,464	1,524,357
Queensland	15,171,074	643,023
South Australia	2,152,612	107,948
Victoria	51,311,050	2,361,698
West Australia	11,976	446
Total	101,730,176	4,637,474

The following table shows the relative position of the different States and the number of dairy factories, including those of bacon-curing, for 1911.

	Butter Factories.	Butter and Cheese Factories Combined.	Cheese Factories.	Bacon Factories.
New South Wales	148	...	31	19
Victoria	155	10	33	25
Queensland	49	...	28	5
South Australia	31	10	13	11

Cheese-Making and Production

The steady advance in prices of cheese is a great attraction for those engaged in butter-making to direct their attention to its manufacture. In some parts of Australia this is really what is happening, and the writer is of the opinion that a good market for cheese will continue for a number of years. The rush to cheese-making in Australia will be most helpful in developing milk production in parts of the country where butter-making has not been a success, and it will have the great advantage of introducing the system of a direct supply of milk to the factories. This will be invaluable to the butter industry later, when the production of cheese has exceeded the demand, or when butter-making and cheese-making are manufactured from milk received at the factory. In this way pasteurisation, with its invaluable qualities to a country like Australia, will become a permanent source of wealth to the butter industry.

The following table gives the prices of New Zealand and Canadian cheese, on the first week in January and the first week in April from 1909 to 1912 inclusive, the advance per cwt. from January to April in these years being for New Zealand 3s. 6d., 7s., 4s. 3d., and 6d., and for Canadian 4s. 6d., 7s., 5s., and 1s. 6d. respectively.

	1909.				1910.				1911.				1912.				Average Rise Jan. to Apr.	
	Jan.		Apr.		Jan.		Apr.		Jan.		Apr.		Jan.		Apr.			
	Cwt. s.	d.	Cwt. s.	d.	Cwt. s.	d.	Cwt. s.	d.	Cwt. s.	d.	Cwt. s.	d.	Cwt. s.	d.	Cwt. s.	d.	s	d.
New Zealand-	60	0	63	6	55	6	62	6	57	6	61	9	73	6	74	0	3	7½
Canadian	60	6	65	0	57	6	64	6	58	6	63	6	75	0	76	6	4	6

Concentrated Milk.—In Queensland the manufacture of concentrated milk engages the attention of five factories, and the value of the present output is estimated at about £140,000. In Victoria and New South Wales concentrated milk is manufactured on a smaller scale.

CREAM AND BUTTER GRADING

In this book attention has been drawn to the chief factors which underlie the manufacture of choice butter. None is shown to be more closely associated with success than cream grading. In Australia this subject has been overlooked, and in consequence the industry in each State has suffered great injury. The policy of factories paying high prices for inferior cream to increase their patrons, and because of fear of offending directors and others who may be suppliers, is much to be regretted. It is the duty of the State Parliaments or the Federal Government to pass legislation to put the cream supply on a permanent basis of honesty and justice to all.

To enforce a workable system offers no difficulty to the States. Queensland has already shown what can be done by certificated cream testers, and the Queensland laws in this direction may well be coveted by farmers in the less fortunate States of the Commonwealth. Provide the factory cream tester with the necessary assistance in the less important mechanical work of testing, and make those who are thoroughly competent, responsible for cream grading. The factory would pay the salary of this employee, but he would be responsible to the Government for his work, and his official certificate would be subject to withdrawal should he be found guilty of irregularities in testing or grading. The grading of cream would be kept up to a standard by the examination of the butter by the official graders who would check the brands. To thoroughly safeguard the factory, and the wholesale and retail buyers, each factory would have specific brands indicative of the grade of butter, and on the boxes the churning number would appear, also the date of manufacture would be indelibly marked in code or otherwise. All boxes tested by the graders would bear the examiner's mark, "tested," with his initials underneath. At London the butter would be finally checked by the State inspectors, and all risks of error eliminated. Such a system would not be expensive, the annual cost would not be a thousandth part of the amount of money that is lost monthly to the respective States of Australia through the absence of compulsory cream and butter grading. The present practice of sending certificates to London is of no real value to the industry.

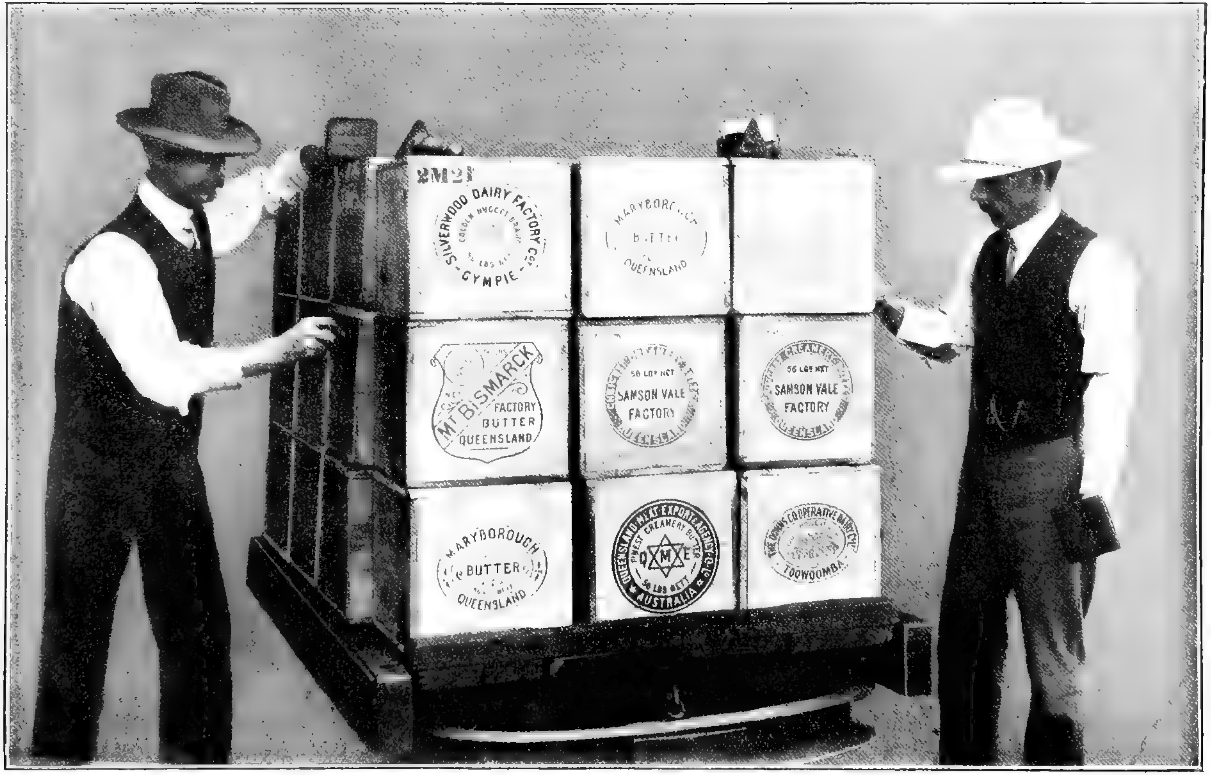


FIG. 68.—Grade Stamping of Export Butter by Queensland Government Officials (Thomson).

The practice of grading butter has very strong supporters in Britain, while in some quarters in Australia it is opposed with bitter determination, and the anti-graders have to some extent been successful in preventing the true value of compulsory grading from becoming known to the Australian people. But the stronghold of the anti-graders would never bear a searching analysis, and many of the arguments that have been persistently voiced against the classing and grade marking of butter are important in showing how hollow their whole case is. One has only to look to New Zealand to be convinced of the value of grading to a country, and if this is insufficient proof, consider what grading has done for Queensland. The latter State of the Commonwealth came rapidly to the front in the production of good marketable butter, and no conscientious person who is acquainted with the industry will deny the fact that Queensland's success is largly attributed to the system of compulsory grading, conducted under the State Dairy Produce Acts. As this is admitted by importers in Britain, why should so much antagonism and hatred be shown to grading?

The anti-grader has tried hard to convince Australia that official grading of export butter in Victoria, or New South Wales, cannot be done satisfactorily, because of the great gulf that lies between the Commonwealth and Britain. This is answered by New Zealand, which is five days further from the British market. But the anti-grader will retort that the Australian conditions being so different to the excellent conditions prevailing in New Zealand, makes good grading in Australia impossible. This is met by a telling reply from Queensland, where the climate is the warmest in the Commonwealth, and where the greatest difficulties to successful grading are encountered. No more need be said of this objection ; let another be considered. It has been well thundered into the ears of Australian factory managers that a second-grade butter will improve on the voyage, and arrive in England in first-class condition This argument will only apply to butter affected with plant flavours, and they are known to all competent graders who exercise their knowledge and judgment before affixing the grade mark on boxes of butter. Not more than 2 per cent. of Australian butter is weedy, which is a very small proportion compared with stale and rancid produce that does not change from a second to a first grade in the journey to London.

It is, however, more than possible that errors in classing butter are made by inspectors, but this should not affect the principle of grading, as a simple remedy for inefficiency is in the hands of the respective Governments of Australia. Faulty temperature is certainly a factor that should not be overlooked (see pp. 448-56). The anti-grader firmly asserts that the Government grade mark is absolutely ignored by British importers and buyers of dairy produce, but this argument can be quickly and thoroughly dispelled by an answer that should prove effective to other questions. When an English importer decides to buy consignments of butter outright in Australia, there is only one sound business way of doing it, and that is upon the official stamp on the boxes.

GRADING IN NEW YORK

The classification of butter and the selling of same according to grade is practised by the New York Mercantile Exchange. There is a Butter Committee which consists of seven members of the Exchange, and all transactions in butter between members of the Exchange are governed by a definite list of rules, from which the following are taken :—

Butter shall be classified as Creamery, Imitation Creamery, Dairy, Factory, Renovated, Packing Stock, etc.

Creamery Butter.—Butter offered under this classification shall have been made in a creamery from cream obtained by the Separator System, or Gathered Cream.

Imitation Creamery Butter shall have been churned by the dairyman, collected in its unsalted, unworked condition and worked, salted, and packed by the dealer or shipper.

Dairy Butter shall be such as is made, salted, and packed by the dairyman, and offered in its original package.

Factory Butter shall have been collected in rolls, lumps, or in whole packages, and reworked by the dealer or shipper.

Renovated Butter shall be made by taking pure butter and melting the same, and rechurning with fresh milk, cream, or skim milk, or other equivalent process.

Grades.—Grades of butter must conform to all requirements specified in the rules, and shall not be determined by the score alone.

Extras shall be composed of the highest grades of butter, and shall average 93 points or higher.
Firsts shall average 87 „ „
Seconds „ 80 „ „
Thirds „ 75 „ „

Fourths shall be a grade just below thirds, and may consist of promiscuous lots.

Sales Under the Call.—Parties wishing to offer butter not described in the foregoing classifications and grades must specify its character.

The State in which butter was made must be named if requested.

If butter has been held, the seller shall name the month in which it was made if requested.

Offers to sell at a lower, or buy at a higher price, shall vacate all previous bids and offerings.

If the butter does not appear to the buyer to be of the class and grade sold, the seller shall be notified not later than 1 P.M. He may then have it inspected, and if it proves not to fulfil the requirements of the sale, he may make a second delivery not later than 3 P.M.

All goods bought, "inspector's certificate attached," shall be accompanied by such certificate, and be accepted by the buyer unconditionally.

Penalties.—When an inspection of butter sold for spot delivery shows the goods not to be of the class and grade sold, the seller shall pay a penalty equal to 5 per cent. (5 %) of the amount of the contract, and the fee for inspection. If the official quotation for the day exceeds the contract price, the seller shall also pay to the buyer in the same way the difference between the contract price and the official quotation.

Inspections.—Inspectors shall brand on the top and side of each package inspected, and when requested, also on the side of each remaining package in the lot, or lots, covered by the inspection.

If butter runs irregular in quality, the inspector shall increase his sample to such an extent as he deems necessary to secure a fair and just inspection.

The butter weigher shall make certificates in duplicate of all lots of butter weighed by him, or his assistants, and promptly deliver to the party ordering the weighing.

There is no grading in Denmark, which is not generally known in the Colonies. The "Lur" brand, with its iron-bound regulations, takes the place of official grading, and is referred to in pp. 297, 374, and 451.

In Ireland a system is followed on the Danish principle, the highest grade of butter being known by the specific title of "Irish Creamery Butter." The description of the butter states that it is an unblended product.

Dairying in New Zealand

The fame of this island possession for dairying has spread far and near. The natural conditions prevailing in New Zealand for the manufacture of high-class butter and cheese cannot be surpassed, and needless to say, the State has taken advantage of the opportunities offered. There are few countries in the world with a more useful Agricultural Department and a better record of work. The year 1912 proved the most successful for New Zealand since the inception of dairying, and we may safely predict even greater results when the full scheme of agricultural reforms and education under consideration by the State are in operation. New Zealand has shown an activity along practical lines, and no matter in which direction one looks on the agricultural map, her efforts have been crowned with success. Quoting from the agricultural report for 1912, the total quantity of butter and cheese exported was 856,801 cwt., valued at £3,816,972, as compared with 795,234 cwt., valued at £3,152,972, for the previous year, an increase of 61,567 cwt. and of £664,000.

The following figures show the totals of butter and cheese exported from New Zealand ports in 1912:—

BUTTER

Port.	Packages, Creamery.	Packages, Dairy.	Packages, Milled.	Total Packages.
Auckland	279,780	168	1,779	281,727
New Plymouth	143,506	3,854	92	147,452
Wanganui	12,239	...	...	12,239
Patea	47,248	118	173	47,539
Wellington	146,150	217	5,504	151,871
Lyttelton and Timaru	20,507	120	205	20,832
Dunedin	22,398	...	1,358	23,756
Totals	671,828	4,477	9,111	685,416

CHEESE

Port.	Packages.
Auckland	9,440
New Plymouth	53,133
Wanganui	2,560
Patea	110,533
Wellington	79,782
Lyttelton	9,596
Dunedin	17,038
Bluff	77,783
	359,865

Instruction in Dairying.—Commenting on this subject the Dairy Commissioner, Mr Cuddie, writes in his annual report :—

"One of the principal functions of this division is the imparting of instruction to those engaged in the many branches of dairying throughout this country. Ten instructors have been engaged on this work during the past year.

"During the winter months the time of the instructors was mainly taken up in visiting the dairy-farm premises for the purpose of endeavouring to bring about any needed improvements in the sanitary conditions of the milking-sheds and surroundings. On the recommendations of these officers many new sheds have been erected on suitable sites, while needed alterations to existing sheds were put in hand without delay. Hundreds of new concrete floors have been laid down, and other requirements of the instructors fulfilled without any objection on the part of the dairymen. We find that this effort is meeting with the support of those engaged in dairying; and our experience goes to show that, if more of the instructor's time could be spared for this work during the milking season, a purer and better supply of milk would be delivered to the factories from many of the farms.

"There is yet an immense field for instruction-work of this kind. More supervision of the conditions under which milk is produced is urgently required, in order to protect the industry from the harmful effects of unsanitary milk. Although a good deal has already been accomplished, no one can estimate the loss that is still going on through the improper treatment of milk on some of the farms in every district. The only remedy available seems to lie in patiently and candidly pointing out the need for better methods. What is most necessary is an increased number of competent officers, who can in a tactful and reasonable way persuade the dairy farmer to follow the right course, and above all, to keep his milking machine and other dairy utensils thoroughly clean, and his milk free from contamination from other sources."

Practical Farm Education.—New Zealand's system of teaching the future agriculturist on the farm, and demonstrating to the local farmers how to make the best uses of Nature, is contained in the appended extract :—

"It should appeal to the agricultural community that the establishment of farm training for young men at Ruakura, in Waikato; Meraroa, between Wellington and Palmerston North; and at Moumahaki, near Waverley, is a development that should be of great importance and value. It is intended to provide accommodation for about fifty young men. The training will be strictly practical, and it is intended to supplement it with lectures and demonstrations.

"*Meraroa.*—The establishment of accommodation for training young men has been noted.

"The Holstein herd has been increased by the addition of three females and a bull of the famous de Kol family from the United States of America. The performances in milk production of some of the members of the herd are phenomenal.

"The following are the records of three of the herd to 31st March 1912:—

Name of Cow.	Date of Calving.	Pounds of Milk.	Test.	Pounds of Butter Fat.
Manola	31st July 1911	16,734	3·1	518,754
Domino	5th Sept. 1911	15,653	3·3	516,714
Spot	8th Aug. 1911	11,846	4·1	485,686

"For the assurance of accuracy an officer of the Dairy Produce Division supervises the work of testing. He sees the milking, compares this with the previous weights, takes samples, and tests the percentage of butter fat. The records of Meraroa are brought as closely as possible to the official test required by breeders' associations throughout the world. The high butter fat test of the cow 'Spot' is most remarkable.

"The Holstein is a milk producer of great volume. It has not been claimed for the breed that the percentage of butter fat is high. The yield of the cow 'Spot' proclaims that a high test is not incompatible with the Holstein cattle. This test is one to chronicle 'Spot' as truly famous among the cows of the world. So is 'Domino' as the producer of 113.3 lb. of milk in twenty-four hours. In this also it has to be remembered that the

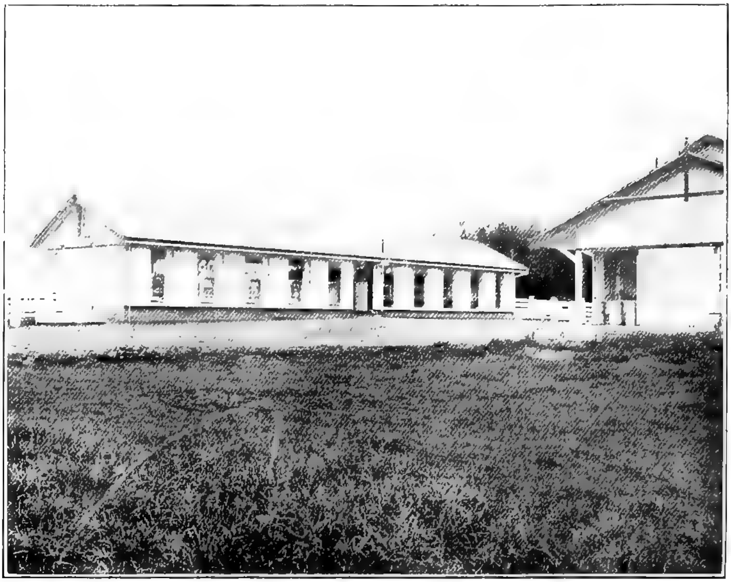


FIG. 69. Outside View of Cow-Shed on a New Zealand Experimental Farm (Dept. Agric. Wellington).

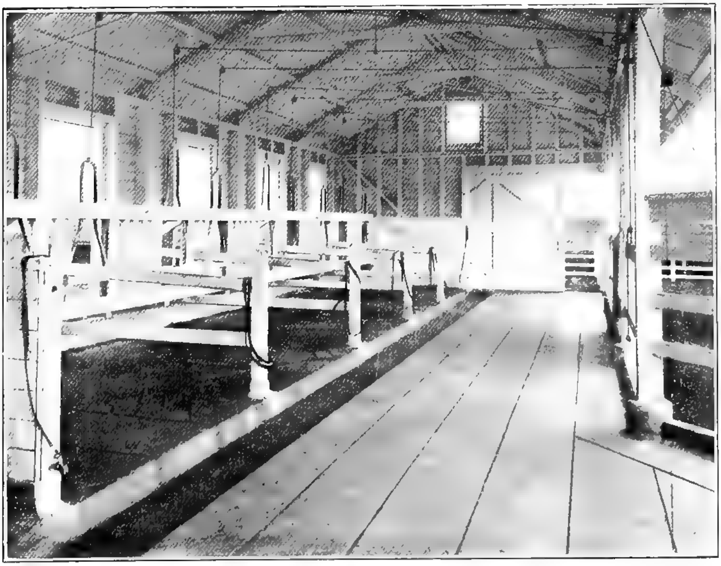


FIG. 70. Inside View.

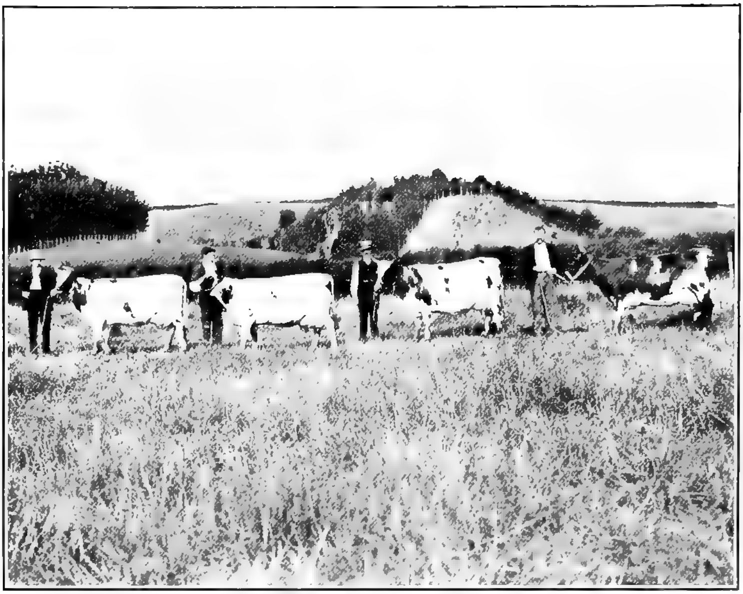


FIG. 71. Group of Ayrshires on a New Zealand Farm (Dept. Agric. Wellington).

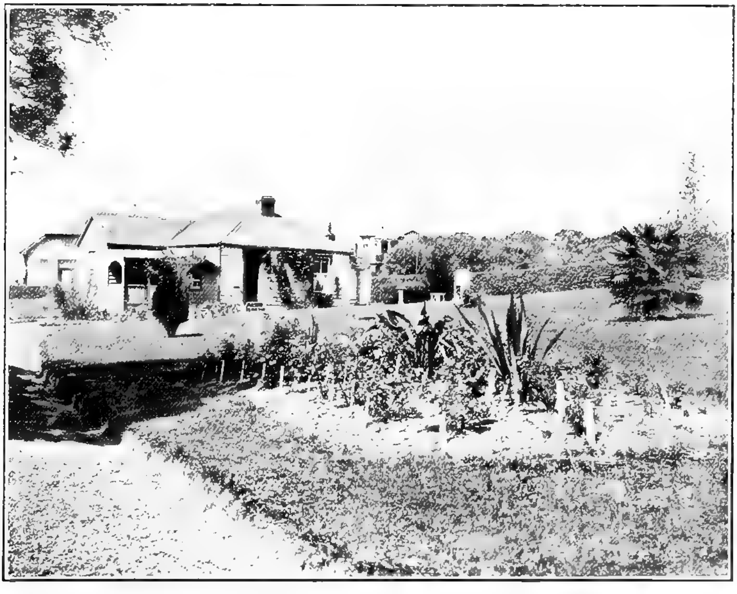


FIG. 72. Government Experimental Farm, New Zealand. Successful Fruit-Growing on Poor Land (Dept. Agric. Wellington).

Meraroa herds are grass-fed. There is no housing or balanced ration or artificial feeding.

"At Meraroa there are also the imported Australian Shorthorns of the milking type. These are pure-bred cattle, and should form a valuable addition to the dairy cattle of the Dominion. The Department is also introducing Guernsey cattle, and a further number of Ayrshires. It is intended to locate these cattle at Meraroa, and to establish that farm as the chief centre of the dairy herds of the State.

"It is not proposed that the State will become a large competitor in the showyard. Some members of the different herds may be permitted to compete to arrive at a comparison of merit; but the great objective is the improvement of the dairy cattle, to maintain a standard of constitution, type, and productivity, all apart from the mandates of the showyard. Simply, the State proposes to breed such cattle that the dairy farmer can select from, with the assurance that his herd will receive material benefit.

"*Moumahaki.*—This also becomes a farm of instruction and training. The Ayrshire herd is located here. It comprises the cattle selected in Scotland for milking qualities.

"At this farm the lucerne fields are one of the greatest and most valuable features. This crop should establish itself throughout the dairy districts of New Zealand. Plant selection and breeding has commenced.

"*Fruit Farms.*—The fruit demonstration farms at Arataki, in Hawke's Bay, and at Tauranga Bay of Plenty, are approaching production. They attract the interest of orchardists in increasing numbers.

"It is submitted that the developments of these institutions of the State commend themselves to the appreciation of the whole agricultural community, and of these developments it may be fairly claimed that farm training for young farmers is the greatest and most valuable not only for the present, but very specially for the future."

Casein.—The manufacture of casein is receiving consideration in New Zealand, and a product of high quality is being turned out. So convinced are the proprietors of the pioneer factory of the value of State grading of produce that arrangements have been entered into with the Agricultural Department for the classifying of the casein exports.

With a view to the development of this new industry, an officer of the Dairy Division of the Government was despatched to Europe last year to make a thorough study of the manufacture of casein, and to ascertain the possibilities of marketing the product.

Dairying in South Africa

South Africa is the youngest of British possessions to establish factory dairying. The industry is being developed at a period in the history of dairying that will be most advantageous to South Africa. Factory construction and equipment, no doubt, will be carefully considered, and the reverses avoided that the pioneers of dairying had to suffer in other parts of the world. The wonderful potentialities of districts in South Africa for dairying should prove a source of wealth in the manufacture of butter and cheese of choice flavour and long keeping properties.

The present position of the dairying industry is reassuring, although a great deal of developing requires to be done. The output of the creameries, which are principally co-operative, varies from 100,000 lb. to 1,000,000 lb. of butter per annum, and the 1911 census gives the figure as 55,102 cwt. for the whole Union. It is anticipated that an export trade in butter with Britain will begin in about six years. This estimate is arrived at by the steady falling off of imports. In 1906, approximately 11,000,000 lb. of butter, valued at £530,000, were imported, principally from Australia; in 1911 this fell to 4,000,000 lb., valued at £193,000, or a reduction of over £330,000 in six years. The retail price of butter in South Africa is very high. In the middle of the summer season 2s. is paid for the best quality, and in winter the price varies from this figure to 3s. 6d. per lb. In the coastal parts butter is seldom cheaper than 1s. 6d. per lb., and at periods it rises to 2s. 6d. per lb. It will therefore be seen that the farmers in South Africa have a ready and remunerative home market. A trial shipment of South African butter was made to London in 1912, the object being to test its carrying properties, and to arouse interest in the future of Africa for the dairy farmer and cattle breeder. The butter was approved by judges, and was marketed at 120s. per cwt. In the south-west districts of the Cape Province there are over 30,000 milk cows, valued at £420,000.

Government Colleges.—The institutions established and controlled by the respective Governments of the Australian Commonwealth, Canada, and South Africa, and the private institutions in New Zealand, have been shown to be indispensable to agriculture and dairying. It has to be admitted that the colonial colleges have an advantage over some of the British institutions in equipment, and having their own farms adds very considerably to their practical value as training schools. Situated in the centre of the farm are the college buildings. Everything is done to afford students a good practical training in all departments of farm labour.

Irrigation.—Australia and South Africa are fully alive to the untold advantages of irrigation for dairy farming, and there is good cause to believe that both countries will make every effort to put to practical purposes the natural resources at their disposal. It is impossible to foresee what this means to countries where the rainfall is uncertain over large areas of fertile lands. In India also, the opportunities for irrigation may revolutionise agriculture, and bring about a huge expansion of the dairying industry. India is blessed with rich valleys that await the brain and skill of the engineer and agriculturist to convert into farms of amazing production.

Canada

The lands of Canada are a source of great attraction for the British emigrant and farmer. Many have crossed the Atlantic, and proved for themselves that Canada offers to the earnest and practical man of Britain, opportunities which his own country refuses to give. No person can gauge the future of the Dominion for agriculture; we only know that its resources are enormous, and the possibilities great. Canada, like Australia, requires population, and she is getting a fair share of Britain's sons and daughters to till the virgin soils of her mighty provinces. The wonderful energy of the various Governments of the Dominion to do justice to agriculture is a feature that cannot fail to strike the Britisher. In practical education she is well to the front, and the wisdom of the Canadian system of blending theory with practice is well demonstrated by the splendid results that have been achieved. In dairying, Guelph College, under the able management of Professor Dean, is honoured beyond the Dominion; likewise is the M'Donald College and other institutions. Mr Ruddick, writing on the subject of Government aid to the dairying industry, says:—

> "Speaking generally, the burden of all purely educational work, such as dairy schools, instruction at cheese factories and creameries, travelling dairies, etc., has been borne by the Provincial Governments. The grants to the Dairyman's Association have, for the most part, come from the same source. These services have been of great advantage and benefit to the dairying industry. When the dairy schools were started in the early 'nineties, many cheese factory and creamery owners were inclined to scoff at the character of the instruction given, but to-day very few owners would care to employ a cheese-maker or butter-maker who had not attended at least one course at some dairy school. The dairy schools in Canada have been conducted along very practical lines, giving the students as much of the scientific side of dairying as they are able to assimilate. The general adoption of the system of factory instruction, after twenty years' trial, is the best proof of the usefulness of that scheme of education."

Canadian Dairy Experts.—In the manufacture of cheddar cheese the world owes a debt of gratitude to Canada. There the industry was extended from the farm to the factory system, and which now may be considered practically perfect. It was from Canada, New Zealand received her early instructors, who put her dairying on a healthy foundation. One was Mr J. A. Kinsella, now deceased, and the other Mr J. A. Ruddick, the present Dairy Commissioner for Canada. Commenting on this subject in one of his recent bulletins, there appears the following interesting acknowledgment :—

> "The first Canadian dairy expert to receive an appointment abroad was Mr R. J. Drummond, who had been a very successful cheese-maker in Oxford county. He was engaged in 1885 to conduct itinerant classes in the south-western counties of Scotland.
>
> "Mr John Robertson, brother of Professor Robertson, was engaged as instructor by the Dairy Association of Wigtonshire and Dumfriesshire in 1888. Mr Robertson gave up the work in 1891, to engage in the commercial side of the dairy business, but Professor Drummond became principal of the Kilmarnock Dairy School in 1889, which position he still holds, with much credit to himself and his Canadian training. The Kilmarnock Dairy School is one of the most successful institutions of its kind in Great Britain."

In addition to provincial help, there is the Dairying Service of the Dominion Aid, which exercises a vigorous national policy of education for the industry. In the report referred to, the following benefits, amongst others, are given :—

1. The cow-testing movement, begun in 1904, has reached large proportions and is still growing. It has for its object the improvement of dairy herds in the important matter of milk yield, and some striking results have already been obtained. The Dominion Dairying Service assumes the full cost of supervising this work, the keeping of the records, and the testing of the samples.

2. In 1902 the Dairying Service undertook to demonstrate the advantages to be derived from the curing of cheese at a proper temperature. It had been well known for years that the ordinary summer temperatures in Canada are too high to produce a cheese with a mild flavour and mellow texture, which qualities have such a high value in cheddar cheese. Owners of cheese factories had been urged to provide the necessary equipment to control the temperature in their curing rooms, but although the

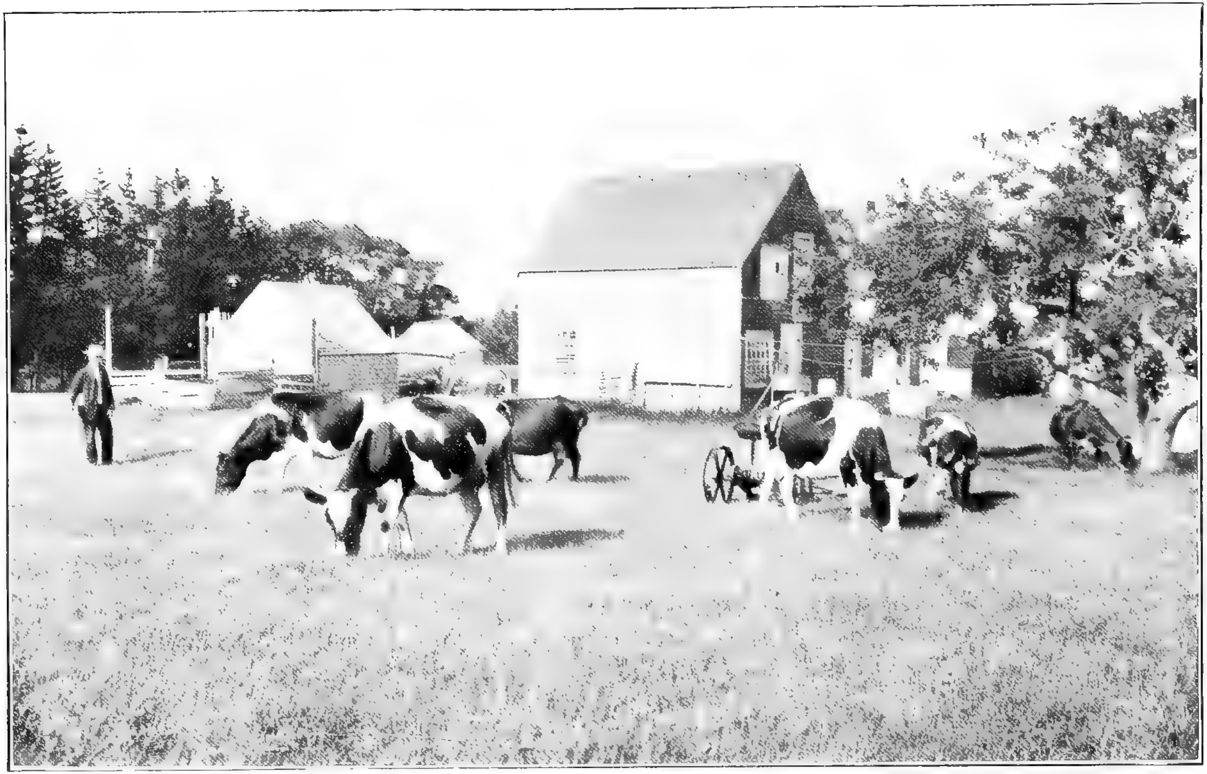


FIG. 73. A Canadian Dairy Farm.

advantages were generally admitted, no progress was made in that direction. It was decided, therefore, to build and equip four large, central, cool cheese-curing rooms, to illustrate in a commercial way the advantages of the proper method of curing. The results were so satisfactory that no cheese factory is now considered up to date unless it is provided with cool curing equipment to prevent the temperature rising higher than 60°.

3. The cargo inspection service at Canadian and British ports, which was inaugurated in 1901, and through which exports are received on the loading and discharge of every shipment of butter and cheese, has enabled the officers of the Department to bring about many improvements in the handling and transportation of dairy produce.

4. The publication of bulletins, giving the results of experimental investigations and other information; a voluminous correspondence, through which inquiries relating to dairying are answered and advice given; and addresses by members of the dairy staff at many meetings throughout the course of a year, are some of the other channels through which assistance is given to the dairy industry.

Showing the position of dairying in Canada, the following tables are given:—

CHEESE FACTORIES, CREAMERIES, AND COMBINED FACTORIES IN CANADA IN 1910

Province.	Cheese Factories.	Creameries.	Combined Factories.	Total.
Ontario	1,083	112	39	1,234
Quebec	1,094	548	523	2,165
New Brunswick	23	14	5	42
Nova Scotia	7	6	1	14
P. E. Island	37	9	...	46
Manitoba	32	20	2	54
Saskatchewan	2	12	...	14
Alberta	12	67	...	79
British Columbia	1	23	...	24
Totals	2,291	811	570	3,672

VALUE IN DOLLARS OF THE EXPORTS OF DAIRY PRODUCTS TO VARIOUS COUNTRIES FOR THE YEAR ENDING MARCH 1911

Country.	Cheese.	Butter.	Cream.	Condensed Milk.	Fresh Milk.	Casein.
Great Britain -	20,577,542	401,621	...	7,583	...	...
United States	36,034	91,313	1,714,528	11,474	5,391	37,009
Newfoundland	39,855	57,198	...	...	...	...
B. W. Indies -	25,844	70,444	...	...	...	...
B. S. Africa	...	...	...	96,457	...	...
Cuba	...	...	...	222,474	...	...
Other countries	60,192	123,712	...	131,418	...	...
Totals	20,739,507	744,288	1,714,528	469,406	5,391	37,009

Total value of all products, $23,710,129.

Irish Dairying

Cattle raising and dairying are large industries in Ireland, and it may be said that both have a great future. The climate of Ireland is well adapted for dairying, and it is somewhat surprising that a greater expansion has not taken place in the winter months, when produce commands the most remunerative prices. Unfortunately it would appear that the summer supplier is overpaid and the winter supplier underpaid for milk. In the face of obstacles the creamery system in Ireland, of which there are now 750 creameries compared with 333 in 1897, has accomplished much for the industry, and the quality of the leading brands of Irish butter is highly creditable. With the help of reforms Ireland will, no doubt, greatly improve her present good position in the English market. And perhaps the introduction of a practical system of cream and butter grading would do more to bring this about than all the educational forces that can be arrayed. Surprise butter inspections are most commendable, but it is questionable if they more than touch the chief weaknesses of the industry.

How the Surprise Inspections are Conducted.—The following is an outline of the scheme: At the option of the Department a telegram may be forwarded to any creamery on the latest published list, requesting the recipient "to send butter that day for inspection" to an address in Dublin or elsewhere.

The butter at each inspection is judged by persons appointed by the Department, and in one or more sections as the Department may consider desirable.

The following scale of points is adopted in judging the butter:—

Flavour		60 points
Texture		30 "
Colour		5 "
Packing and finish		5 "
	Total	100 points

A schedule giving, in such form as the Department may decide, the results of the judging of the butter received from each creamery participating in the inspection, is issued after each inspection to all the participating creameries. In addition, notes of any particular defect or defects observed in any lot of butter may be communicated to the manufacturer for the purpose of indicating the points in which improvement is especially required. If so desired, an instructor in dairying is directed to visit the creamery for the purpose of assisting the manager to remedy any defect, which can be most satisfactorily dealt with by means of such assistance.

Certain conditions have to be complied with in respect to each lot of butter that is forwarded to the inspectors.

The following tables show the numbers of milch cows in Ireland in each of the last ten years; the prices received in Irish market towns for Irish butter for the same period; the quantity and estimated value of butter exported from Ireland for each year since and including 1904; and, lastly, the quantity of butter exported for each month of the years 1909, 1910, and 1911.

Table showing the number of milch cows[1] in Ireland in June of each year from 1903-12:—

Year.	Milch Cows. No.	Year.	Milch Cows. No.
1903	1,495,179	1908	1,586,425
1904	1,497,647	1909	1,548,936
1905	1,487,064	1910	1,557,584
1906	1,496,284	1911	1,565,418
1907	1,561,463	1912	1,598,986

Table showing the average prices in shillings per cwt. of creamery, factory, and farmers' butter, also butter (unclassified), for each of the eleven years 1902-12:

Year.	Creamery Butter.	Factory Butter.	Farmers' Butter.	Butter (unclassified).
1902	..	...	...	96.4
1903	...	...	...	93.10
1904	...	...	...	89.8
1905	102.1	94.9	89.11	99.6
1906	103.10	88.8	89.9	101.6
1907	101.9	85.0	86.1	98.0
1908	109.2	97.9	98.5	107.1
1909	104.9	90.1	89.7	100.9
1910	106.9	94.6	94.0	102.7
1911	112.11	95.5	95.0	106.8
1912	113.6	98.10	98 0	106.10

Note.—The prices of creamery, factory, and farmers' butter were not recorded separately until the year 1905.

Table showing the quantity and estimated value of butter exported from Ireland during each of the years 1904-11 inclusive:—

---

[1] Including heifers in calf.

Year.	Quantity.	Estimated Value.
	Cwt.	£
1904	818,252	3,666,792
1905	813,921	4,048,409
1906	844,027	4,283,437
1907	818,004	4,009,072
1908	751,942	4,026,023
1909	719,625	3,625,111
1910	698,907	3,584,810
1911	688,362	3,671,264

Table showing the quantity of butter exported from Ireland during each month of the years 1909, 1910, and 1911:—

	1909.	1910.	1911.
	Cwt.	Cwt.	Cwt.
January	18,140	14,244	15,553
February	11,753	11,189	12,602
March	16,490	11,396	14,486
April	30,003	22,652	22,975
May	60,127	55,624	56,505
June -	113,495	101,717	105,328
July	126,109	109,574	103,714
August	108,052	116,897	92,549
September	87,291	92,589	86,145
October	76,165	77,860	90,213
November -	45,507	53,295	63,375
December	26,493	31,870	24,917

In 1912 approximately 5,000 cwt. of cheese were exported from Ireland, and about the same quantity of casein and milk powder. In 1911, 254,560 cwt. of condensed milk, 7,164 cwt. of whole and separated milk, and 15,162 cwt. of cream were exported. Of recent years there has been a marked increase in passenger train and parcel post traffic in Ireland, which is not included in the export figures.

Pig-Breeding and Bacon-Curing

In the breeding and rearing of pigs for market there are very great prospects, and this may be said to apply to all countries of the world. The consumption of pork and bacon is increasing annually, and travellers abroad recognise that the British dish, "Ham and eggs," is becoming popular amongst peoples that hitherto were ignorant of its existence—far less its attractive qualities. Go where you like, the demand for products of the pig is increasing, and the stud-breeders of Britain should have a harvest before them in meeting the requirements of countries that are giving attention to the improvement of native pigs, as well as establishing pure breeds. In Russia, Austro-Hungary, Servia, and other parts of the Balkans, the pig industry is an item of considerable concern. Previous to the war Servia was developing a promising export trade in pork, and when the war is over the Balkans should be a useful field for the operations of the British pig-breeders. The native pig in the countries named is inferior, and crosses with the Berkshire have proved thoroughly successful. This will give a wonderful impetus to the industry. In Britain the breeding of pure stock has claimed attention. The raising of pigs for market, and for bacon, has not grown to the extent one would like to see. The present opportunity should therefore not be lost to put this branch of dairying on a staple footing. Farmers should co-operate as this work suggests, and establish their own bacon factories, to be run in conjunction with butter, cheese, and condensed milk factories. There is a harvest in this business if properly organised and managed. In Australia, butter and cheese factories engage in pig-raising on a very large scale, and the profits from this branch, in some cases, far exceed the factory results. In the South of Scotland we have also the best of evidence in support of the enterprise. At dairy factories much of the by-products go to waste that could be profitably used if pigs were kept. The following figures show how ham and bacon curing has developed in Australia.

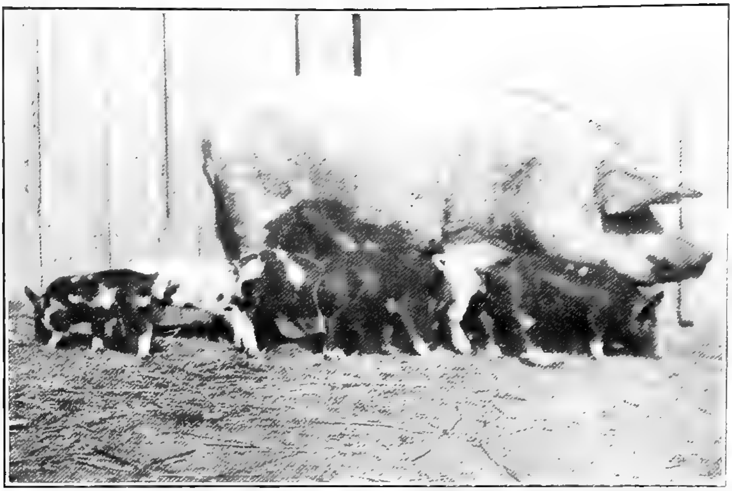


Fig. 74.—Native Balkan Sow with Litter of Berkshire Crosses (Thomson).

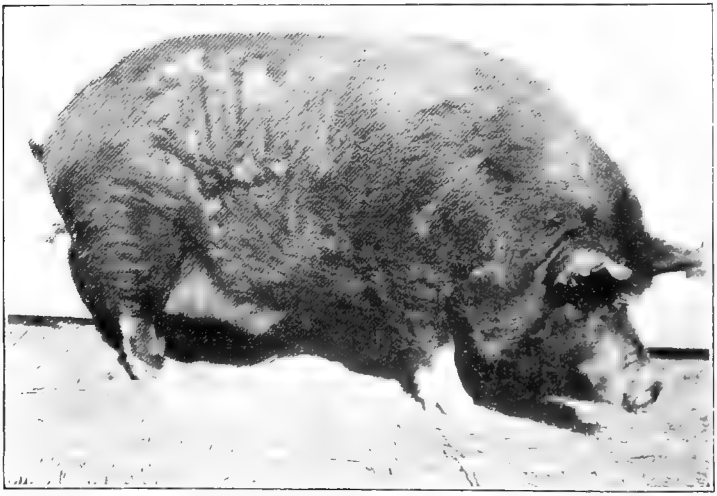


Fig. 75.—Berkshire-Balkan Cross (Thomson).

PRODUCTION OF BACON AND HAM FOR 1910 AND 1911

	1909-1910.	1910-1911.
	Lb.	Lb.
New South Wales	9,931,377	12,620,067
Queensland	9,228,317	10,758,963
South Australia	3,348,050	3,741,942
Tasmania	1,526,115	1,468,789
Victoria	13,620,485	16,438,837
Western Australia	120,623	121,154
Totals -	37,774.967	45,149,752

In Ireland, pig-raising, bacon and ham curing are well established, and there is nothing to prevent the industry from growing to far greater dimensions. Belfast hams are known far and near for their very excellent quality. The following figures, supplied by the Irish Department of Agriculture, will be of interest :—

SHOWING THE NUMBER OF PIGS OF DIFFERENT CLASSES IN IRELAND IN JUNE OF EACH OF THE YEARS 1903 TO 1912, AND THE NUMBER OF PIGS KILLED OR BOUGHT DEAD FOR CURING IN EACH OF THE YEARS 1908 TO 1912.

Year.	Pigs Kept for Breeding Purposes.		Other Pigs.		Total Number of Pigs.	Number of Pigs Killed or Bought Dead for Curing.
	Boars.	Sows.	[1] Six Months Old and Upwards.	[1] Under Six Months.		
[1] 1903	2,044	147,807	34,839	1.198,826	1,383,516	Figures not available.
[1] 1904	1,867	133.540	29,131	1,150,588	1,315,126	
[1] 1905	1,736	121,840	24,675	1,016,065	1,164.316	
1906	1,855	134,478	102,744	1,005,116	1,244,193	
1907	2,100	142,405	128,970	1,043,593	1,317,068	
1908	1,939	123,666	149,631	942,604	1,217,840	1.177,737
1909	1,791	120,485	125,319	901,584	1,149,179	1,145,625
1910	1,779	129,787	136,279	932,160	1,200,005	1,143,025
1911	2,113	149,315	177,365	1,086,326	1,415,119	1,253,197
1912	1,889	130,842	176,863	1,014,363	1,323,957	1.416,765

[1] Previous to the year 1906, "Other Pigs" were enumerated under the heading "One Year Old and Upwards" and "Under One Year."

TABLE SHOWING THE NUMBERS AND VALUES OF FAT AND STORE SWINE, AND THE QUANTITIES AND VALUES OF BACON, HAMS, ETC., EXPORTED FROM IRELAND IN EACH OF THE YEARS 1904 TO 1911.

	UNIT OF QUANTITY.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
					QUANTITIES.				
Swine, Fat	No.	478,922	362,791	409,510	448,578	371,537	316,891	301,576	323,574
,, Store	,,	26,325	1,032	19,920	33,329	15,939	10,238	22,495	18,766
Bacon	Cwt.	780,405	712,984	721,130	859,608	916,677	888,713	886,986	906,834
Hams		121,061	107,014	115,920	120,021	127,056	116,077	117,506	126,242
Pork		45,293	43,769	51,006	45,846	47,338	34,803	49,766	49,129
Sausages		...	...	298	282	52	68	153	240
Lard	,,	135,463	133,288	130,314	140,321	138,370	102,310	123,524	113,895
					VALUES.				
		£	£	£	£	£	£	£	£
Swine, Fat	No.	1,670,227	1,269,769	1,433,285	1,570,023	1,300,380	1,426,010	1,281,698	1,294,296
,, Store	,,	65,812	2,322	44,820	66,658	31,878	25,595	50,614	37,532
Bacon	Cwt.	1,951,013	2,067,654	2,163,390	2,492,803	2,566,606	2,932.753	3,104,451	2,900,502
Hams		484,244	470,802	521,040	504,088	539,088	533,954	587,530	593,337
Pork		106,439	102,857	110,864	107,738	113,011	96,143	149,920	125,279
Sausages		...	...	974	921	170	222	500	804
Lard	,,	328,498	333,220	354,416	389,391	397,814	503,161	378,292	316,059

Dairying in Siberia

The prominence of dairying in Siberia warrants more than a passing comment in this book. The name Siberia gives a chill to the average British subject, and one is inclined to picture that mighty Russian possession as a waste in the eternal grip of winter. Nothing could be more erroneous. The summer of Siberia is hot and the country is in a rich mantle of verdure. Winter is cold and dry, but very healthy for man and beast. It is only about twenty years ago when dairying was inaugurated in Siberia. Since then butter production has grown by leaps and bounds along a thousand miles of steppe, traversed by one single railway. There are tremendous stretches of fertile land lying idle in the south, also thousands of miles in the east and west that have not yet been inhabited by peasant farmers.

The Russian Government is fully alive to the possibilities of Siberia, and it is contemplated by the State to spend £20,000,000 in railway construction. The erection of Government cool stores is at present under consideration, also the grading of butter on the New Zealand and Australian systems. It is believed by the Government this will raise the standard of Siberian butter exports. At present the custom is to pay the peasant co-operative societies practically the same price for second-class butter as for first grade. This is really demanded by the peasant, with the result that improvement in the quality is being retarded. There is no doubt that compulsory grading of cream and butter is the quickest and most effective way of building the industry on a sound and profitable foundation.

It has been stated in this book that Russia with other foreign countries offers good opportunities for British breeds of cattle and pigs. Already the Shorthorn and the Jersey breeds are to be found on Siberian estates of the rich, and it is only a matter of time when a steady demand will be created for improved milking stock. It is the smallholder who is the backbone of Siberian dairying, just as we find in Denmark, Sweden, France, and, nearer home, Ireland.

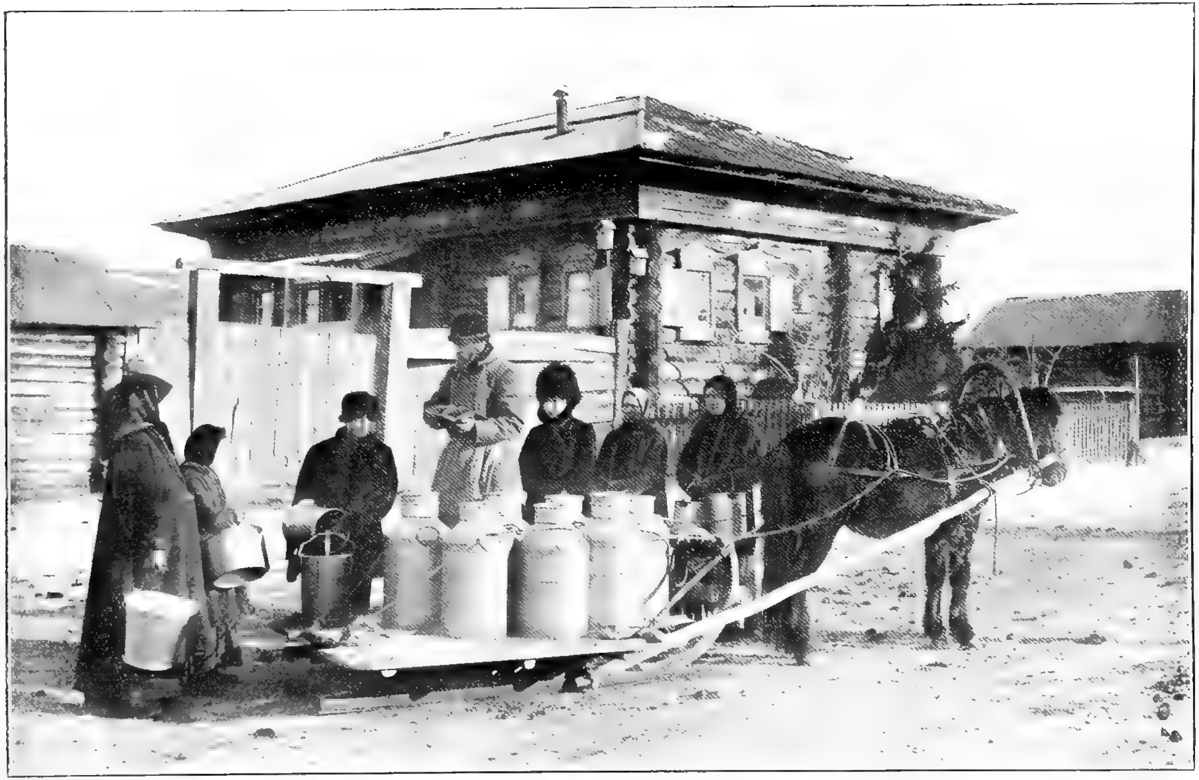


Fig. 76. Transporting Cream in Siberia.

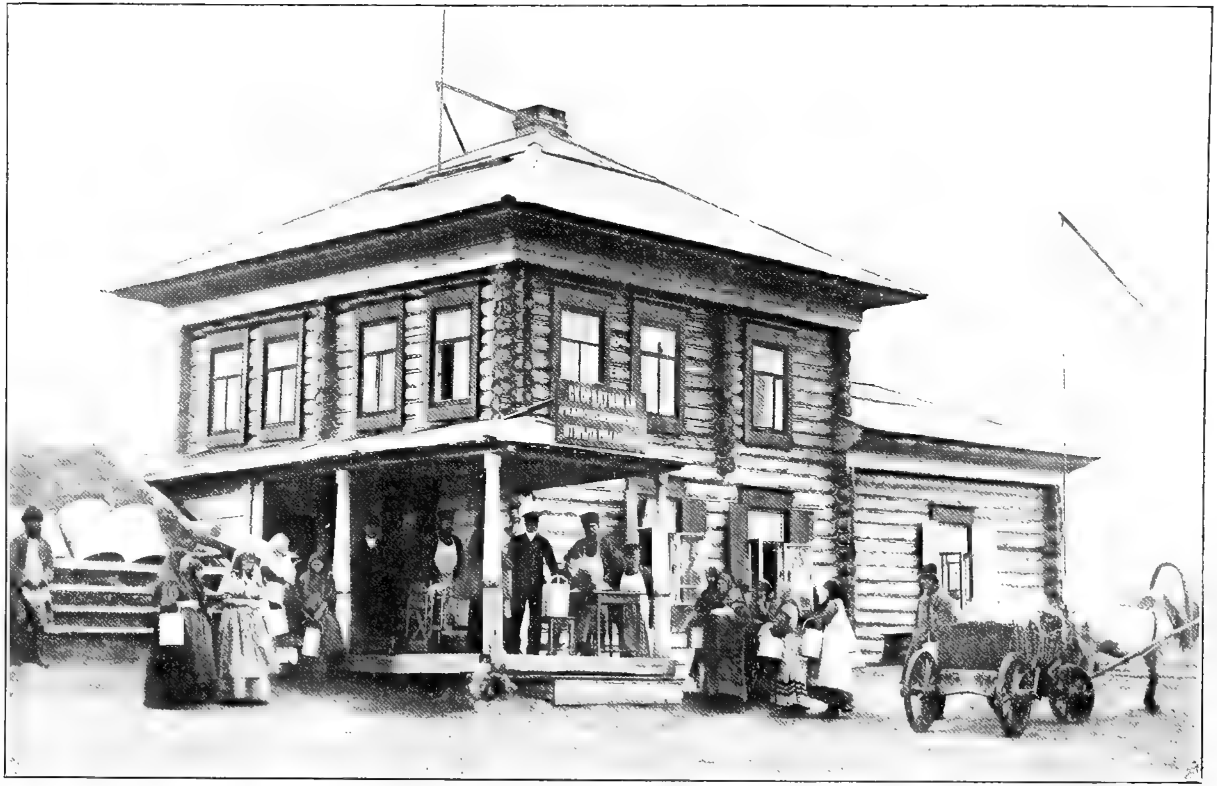


FIG. 77. Siberian Creamery.

The following interesting report from a resident in Siberia will show readers that dairying is still in its infancy in that country:—

"Farming in Russia and Western Siberia is carried on in a manner peculiar to the country. Owing to the vast stretches of land and transport difficulties, the peasant farmers have established themselves in the villages or communes. Every house has its yard at the back (corresponding to a farmyard) in which are the byres and stables, and over these primitive buildings is the hay loft. Each farmer keeps on an average from three to five cows, and a horse or two. It is only occasionally that we find a farmer here, say, with twenty to fifty cows. On one side of the village is the common pasture land, where all the cows graze together, the owners paying into the town treasury a tax of a few roubles per head. The land on the other side of the village is measured out at so many dessatives per inhabitant, for wheat and corn growing. A family of sons and daughters get more land than when the household comprises only two persons.

"The cultivation of the soil is done in a very primitive manner, the implements being drawn by horses, oxen, and occasionally dromedaries. I know a few people who favour the latter as they can subsist on next to nothing. Little or no manure is used, and the byre and stable refuse is carted into the nearest hole outside the commune. Twice a year in the spring and autumn the roads are almost impassable, particularly in the spring when the melting snow plays great havoc.

"In summer time the weather is warmer than in England, and often the difference between the day and night temperature is considerable.

"Villages having thousands of cows establish creameries on the co-operative principle. Only about a quarter of the Siberian creameries are privately owned. The Russian Government greatly assist the co-operative movement through their dairy instructors, and the farmers get more justice than from private traders. My experience of the uneducated Siberian farmer is that he can always look after himself, and rather well, too, when he gets you under his thumb. Creameries are erected and equipped on credit. The peasants prefer to wait for evidence of the success of the creamery before they take any risks with their own money. Two people are selected, one to make the butter and run the technical part, the other to buy and sell. A power of attorney for this purpose is obtained.

"The milk is purchased by measure (not weight). Butter fat tests are only made when adulteration is suspected. You can understand the testing difficulty when a dairy has a thousand milk suppliers, each with only three or four cows on an average.

"The milk is separated, only an occasional dairy pasteurising. This to the farmer costs money, therefore he avoids it. In fact, they don't want steam dairies, because the expenses are higher than when the machinery is run by hand or horse power. Cleanliness on the whole is rather awanting. However, butter can always be sold at a fair price, so great is the competition. A beautiful quality is produced at many of the dairies—probably more by accident than skill in making. The butters are carted to the market by the power of attorney man some two to four times per month, and sold to the merchants (foreign), 'cash on the nail' being the terms. At the end of each month the dairy prepares a 'balance-sheet' to find out how much they can pay per pood of milk supplied. Neighbouring dairies are always comparing prices, and the sellers who get the lower prices have to submit to a lot of annoyance from their enemies in the village. On returning home with a bad price they are often dispensed with, and others elected to take their place.

"The bulk of the butters are bought and shipped by Danish firms, there being only one or two English firms in the industry. It seems strange that nearly all the London importers should have to go to foreign exporters in Siberia for their supplies."

SHIPMENTS OF BUTTER FROM SIBERIA, 1908-12

	1908	1909	1910	1911	to Oct. 1912
Casks	353,213.	954,745.	954,745.	1,035,729.	1,003,365.

A cask is equivalent to 122 lb.

Value of Russian dairy produce in 1895 was £300,000; in 1910, £5,300,000.
Value of Russian agricultural produce in 1895 was £400,000,000; in 1910, £900,000,000.

Dairying in Denmark and Sweden

Several references have already been made to Danish dairying. To thoroughly appreciate the methods employed in that country which have contributed to successful dairying, it is necessary to go to Denmark and study the industry on the spot. The following extract from a Danish paper will be of some interest :—

"In no other country does everything give place to dairying as it does in Denmark, and in no other country in the world are the farmers so prosperous and self-respecting.

"The aim of the Danish farmer is to keep the largest number of efficient cows possible on a given area,—a cow to 2½ acres or less. Enough young stock is raised to keep the herd supplied with cows.

"An immense amount of manure of fine quality is made, and with their careful methods of husbanding the solids in a covered manure pit, and the liquids in a cistern, and applying in small quantities at frequent intervals during the rotation, the producing power of their land is increasing from year to year.

"The development of the breeds in twenty-five years has been due to the farmers' skill, intelligence, and common sense, in selecting and breeding for milk production alone. Only the best heifers are raised, and with the record of the dam and the qualities of the sire known, their selection is comparatively simple. The cows are treated with kindness, and every effort is made to have them comfortable at all times. On many farms the cows are regularly groomed.

"Cows are seldom turned to pasture in Denmark, but tethered by means of a halter on the head and a rope or chain 12 to 20 ft. long, which is attached to a 10-in. pin driven into the ground. The cows are moved, five times a day, from 3 to 6 ft., depending upon the amount of feed. This is the Dane's chief point of economy in summer feed.

"Many small dairymen take the cows to the stable to be milked three times a day. They are stabled all winter, fed all the straw they will eat, and on the average 4 lb. of hay, 40 to 100 lb. of roots, and about 6 lb. of grain per day, consisting of oil cake, bran, barley, and oats.

"An even flow of milk is required the year around, and most of the cows freshen from September to May.

"The co-operative cow-testing associations, begun in 1895, have proven so helpful in weeding out the unprofitable cows, that they have rapidly increased to about five hundred associations. A man is employed by each association to visit the farms and do the testing every three weeks. He weighs the milk and keeps an accurate record of the feed consumed, so the net profit per year of each individual cow can be ascertained.

"There are 1,100 co-operative and 300 private creameries in Denmark. These manufacture over 200,000,000 lb. of butter a year. In summer the milk is delivered twice a day and in winter once.

"Stringent rules are laid down in regard to cooling the milk on the farm and in not mixing morning's and evening's milk. All foods which may impart objectionable flavour to the milk are forbidden.

"The creameries are compelled by law to pasteurise all skim milk by heating to 180° before it leaves the factory, to prevent the spread of tuberculosis through this medium. The loyalty of the Danes makes it rarely, if ever, necessary to impose the penalties. The skim milk is converted into bacon hogs and the bacon exported to England."

Surprise Butter Competitions.—This is managed by a special official department in Denmark, and is of sound commercial value to the industry, as well as educational to factory managers and employees. The competitions are done in a most thorough way, and diplomas of honour are given to factory managers who excel in the tests. Having once had the privilege to study the entire scheme, it was very clearly shown that the Dane knows how to infuse practice with science to the best advantage. In research work, Denmark owes much to such scholars as Storch and Bang. These famous men are loved and honoured by all Denmark.

Sweden

Of late years Sweden has taken a prominent place in the manufacture and export of butter, and strong efforts are being made by the Government to further improve the quality. Dairying education is well advanced in Sweden, and the chief agricultural training centre at Alnarp is one of the finest in Europe. This institution may be said to be complete in equipping the student for any branch of agriculture. Practical tuition has always been the bed-rock of Swedish teaching, and distinguished names are associated with the industry, amongst whom the following may be mentioned: Gussander, Schwartz, De Laval, and Lindstrom, the inventor of the Omega milking machine.

A question of considerable importance at the present time is the application of a title or brand termed "Rune" to butter produced in Sweden. On this subject Mr Bagge, Commissioner in London to the Swedish Government, confirms the following remarks:—

Since 1905 the "Rune" brand has been registered as the hall mark of quality of Swedish butter. The example of Denmark has been followed in this respect though the "Rune" brand has been exclusively applied to the best butter, while in Denmark the "Lur" brand until this year was used for the general output. The Swedish Government were prompted in the action they took in 1905 in order to give an assurance that Swedish butter would be sold in Great Britain as the product of Sweden, and to prevent the butter of other countries from being disposed of as Swedish; also purchasers of the Swedish article bearing the name of "Rune" can rely on getting a first-class product. Another important reason is that an incentive will be given to creameries and factories to improve their general output of butter. It is not only the good quality that sanctions the use of the title "Rune"; there are other stipulations than the undernoted which must be fulfilled by manufacturers.

That the cream or the milk used for butter-making shall be pasteurised to 176° F.

That the moisture in the butter shall not exceed 16 per cent.

The object of these provisions is, firstly, to safeguard the health of consumers of the butter; secondly, to comply with the law of Britain.

In maintaining the good name of Swedish dairy exports, the Government employs a number of experts who travel throughout the country for this purpose, and the agricultural societies of each province have similar officials, also experts are engaged to supervise over the testing of exports. Adulteration of produce has been carefully considered by the Swedish authorities, and in 1906 the following regulation was passed into law:—

"That all margarine manufactured in or imported into Sweden shall contain at least 10 per cent. of Sesame oil." By this means the mixing of margarine with butter or *vice versa* can be detected by analysis. In Sweden no attempt has been made to interfere with the colouring of margarine, which is similar to butter, but in Denmark colouring is not allowed.

In Sweden, dairying is more profitably practised in winter than in summer. The present weekly shipments of butter to Britain are approximately 7,000 cwt. A reduction is anticipated owing to the large trade that is done with Germany in cream which is manufactured into butter in that country. Germany imposes no tariff on the raw produce, and there are still four years to run before this arrangement expires with the Swedish Government.

Poultry Raising

Of recent years poultry farming is claiming close attention in all countries. There is certainly much to say in its favour as a profitable occupation for the man with small capital, and as an auxiliary of the dairy farm. The value of egg production and the rearing of birds for table use and other purposes have been brought steadily before the people of England by that indefatigable worker and authority on the subject, Mr Edward Brown, F.L.S. In Wales where smallholders are numerous, the benefits of practical instruction in branches of poultry farming are being distinctly felt, and the Canadian system of instructing the people "by train" is to be heartily commended. There is a splendid field in Britain for the industry, and no doubt a rapid expansion will take place in the next few years. In Australia and New Zealand poultry farming is receiving great encouragement. At the Roseworthy Agricultural College in South Australia, Dookie in Victoria, Hawkesbury in New South Wales, and Gatton in Queensland, each in turn has conducted exhaustive competitions to test the utility of different breeds of poultry. All Australia was interested in these eminently practical tests, with the result that poultry raising became an established industry throughout the Commonwealth. Australian methods of agricultural education get the name of being severely practical, but who can ridicule Australia when the agricultural industries respond in a healthy and vigorous manner to her system of demonstrative teaching? On this basis her export produce trade has developed marvellously. All agree that Britain will never supply her requirements in eggs and poultry, but this is not a sufficient excuse for the backwardness of poultry farming. And it might be added that foreign imports of eggs and poultry are not free from responsibilities of bringing foot-and-mouth disease into the country. Those who have had a personal insight into the poultry business abroad, where foot-and-mouth disease abounds, and have seen the collecting and packing of eggs for export, can form an opinion of the extent of the danger indicated.

Flower and Fruit Culture.—With this subject we might be said to conclude the branches that are associated with dairy farming. In England, with its comparatively mild climate, and where the demand for flowers and fruit of all kinds is generally good, the writer is tempted to include this special department.

The late Mr John Speir, who did so much for Scotch dairying, and whose name will ever be associated with milk records, proved that gardening and dairy farming can be worked together very successfully. In Hungary great service has been done by the State to encourage the cultivation of fruit amongst farmers. The traveller in Hungary cannot fail to see rows of fruit trees along the roads which subdivide the farms. These trees represent different kinds of fruits, and they have been planted by the State to illustrate to the farmers which class of fruit and variety suit their particular soils and conditions. "Seeing is believing." The farmer profits by this class of practical education which is brought to his door in so convincing a way. There is much that the British educationalist can learn in most foreign countries.

State Aid to Dairying

The magnitude of dairying in Denmark, and the success of the industry, is attributed to a number of factors. We are told that co-operation has wrought miracles amongst the Danes, and to this and this alone the present happy position of the country belongs. In the first place, Denmark is not essentially a dairying country, it is too flat, and the summer and winter climates show extremes of temperature; but the Dane is a born smallholder, and he is by instinct a man of the land. The writer has studied the methods of the Dane and the Swede in their own countries, also in other dairying countries where numbers have settled, and conclusions have been drawn on certain points of importance. In their native homes these people are plodders; they accept guidance readily, and they work methodically and systematically. The British peasant farmer goes to the Colonies to prove his worth; and those emigrants who have amassed riches and become great farmers in British oversea possessions have not done so without expending as much energy, and exercising as much intelligence, as they would have done in the old land had the opportunities been given them. The Dane is by nature content with small riches and a humble life. He has all the practical qualities to make a successful man of co-operation, and the Dane is loyal to every law that co-operation demands for success. He sees the goal, he is led to it, and he loves his country for a life on the land. Private ownership is sacred to the Dane, and he is happy nursing, so to speak, his own little possession.

There is nothing very fascinating about the architecture and appearance of Danish farms and factories—the writer has seen many better in other countries, and many worse; but there are co-operative methods, and common-sense practices in almost everything the Dane does. So he has made butter-making pay, cheese-making pay, poultry pay, and the pig provides a rich harvest for the country. But who, might the writer ask, has shown the Dane how to do all this? The State has moulded the dairying industry of Denmark. A system of dairying that has been demonstrated by the State to be the best, most economical and profitable, has been practised by the peasantry. Not one important step in Danish dairying has been overlooked by the eminently practical and intellectual men who guide the destinies of the Danish peasant. In that country you have the practice of dairy science woven with economical and commercial practices of agriculture.

Denmark is an enormous exporter for her size, and we are told she exports more than she produces. The writer has sampled on a number of occasions butter in Danish restaurants, hotels, and in private houses, that had its origin in other lands. So imbued is the Dane with the welfare of his own country in the export of produce that he is happy to live on cheaper imports.

Danish winter dairying is an object lesson of State aid to the farmer. He looked on with an open mind, and saw it proved that winter dairying had a wealth in store for him and his country, and he followed the advice given. It is a glorious victory for Danish education, Danish methods, and Danish common sense that this little kingdom holds the honours of the British butter market for the twelve months of the year in the face of countries better endowed by Nature for such a distinction.

State dairy farms should be the backbone of dairying in every country. Such an innovation in new countries will prove the right from the wrong practices,and remove the mist that lies between the young farmer and success. It is not the duty of the man of humble means to experiment on a scale that will determine which will be the most profitable system of farming for him to adopt, and in which directions he must take particular precautions or show special zeal. Hard-earned money might be lost, and much enthusiasm and energy wasted, and, perhaps, total failure might be the fate of honest and strenuous endeavours to achieve success. In Australia and Canada, State farms have long been in existence. Some "bankruptcies" have occurred, but the gain to the country by the successful ones has been enormous. Failures have resulted from no fault of the principle; it has been the fault of establishing the farms in parts of the country that were never intended for mixed farming or crofter settlement. In Australia, State dairy farms are being established in different centres to demonstrate to farmers the profitable from the unprofitable methods and practices, and to show what the district is capable of doing in the various departments of the industry. The State will test the latest dairy appliances, the value of forage and other crops, various breeds and methods of breeding will be considered, and where there are successes the farmer will have an object lesson before him, and where there are failures following conclusive tests, indirect profit will be realised.

A State farm should be established to show what is best suited to the country and the district, and how it may be made to yield the greatest gain to the producer. The writer has already said that Great Britain and Ireland have a mighty future for stock-breeding, dairying, and the allied branches. All that is required is development along the proper lines, and a genuine sympathy between producer and consumer.

Surprise Competitions for Dairy Farmers

Based on what has been written in this work on the hatching of good and bad bacteria in and around the dairy and the inestimable value of cleanliness and approved methods to dairying, it is reasonable to suggest that workable schemes should be put into practice to help tenant farmers to more fully recognise and appreciate the conditions upon which success in dairying is established. The most costly defects in butter, as this book clearly shows, are not directly attributed to the manufacturer, the weakness is found in the raw produce, and the energies of the educationalist should be centred to especially purify the source of supply. As already recommended properly organised and well managed dairy farmers' associations should be in operation in all districts, and were this done immense good would be likely to result. For example, prizes might be offered for the best kept dairies, and surprise competitions held amongst the members to decide the winners. The adjudicators would necessarily be thoroughly practical men whose views would be respected on dairying matters generally, and they might have the assistance of an additional judge who was sound in theoretical knowledge. Schemes of this kind would illustrate the weaknesses of dairying over which the farmer has no control, and those which he can control, and it would show to educational authorities in which direction instruction is chiefly required, and how it may be best applied. In competitions of this kind, schools might co-operate for the special benefit of the sons and daughters of cowkeepers and tenant dairy farmers. Visits to the prize dairy farms by the scholars would be useful, and essay writing on what they had seen would increase their interest in the subject, and exercise a good influence.

The following is a suggested scale of points and an example of judging :—

	Max. Points.	Points Awarded.
A. Cleanliness of dairy buildings, cows, and milking -	60	50
B. Cleanliness of immediate surroundings	35	32
C. Cleanliness of utensils	30	25
D. Equipment (property of farmer)	25	20
E. Management of the dairy	25	23
F. General conduct of the farm	25	25
	200	175

Remarks.—We offer the following comments under the various headings.

A. Ventilate the buildings more thoroughly, keeping the air pure and healthy.

Give the walls a fresh coating of lime wash, using the lime recipe which was given you on day of visit.

Sweeping the cowshed immediately before milking is not recommended for reasons which were explained.

Milk strippings which were taken for fat tests from cows named Daisy and Mary showed 7.5 and 7.8 per cent. respectively.

We heartily commend the way hand milking is practised.

B. Satisfactory.

C. Cleansing might be followed with greater advantages if the appliances were more thoroughly aired after washing.

D. Satisfactory, although a few of the milk churns might be renewed with profit, and the sieve in use is attendant with danger to the keeping properties of the milk.

E. Very satisfactory.

F. Excellent.

As regards defects in buildings, sanitation, and water supply for which you are not responsible, these will be brought under the notice of the proper authority.

Assisting the Settler

As a guide to dairy farming in Britain and the Colonies it is necessary that the settler should be acquainted with the cost of stocking and equipping farms of average size. Diversity of opinion exists amongst practical farmers of all countries in preparing an estimate of the requirements and cost of same.

Australia has clearly demonstrated how thoroughly the estate owners and working dairymen can co-operate to their mutual advantage. Dairy farming by shares has been in operation in the various Australian States for many years, and hundreds of farmers to-day owe success to this attractive system. It is very simply worked, no difficulty whatever being met with in subdividing large estates into suitable holdings. In Queensland, for example, the landed proprietor or company, as the case may be, provides the land, house, live stock, and generally equips the farm. The tenant keeps it in repair, accounts are paid monthly, and all business transactions are done through a competent manager, who supervises the work of the tenants. He is their adviser and instructor, so to speak. The profits are equally divided between the owner and the tenant, and with the very excellent object of raising the standard of the dairy herd, the tenant is paid from 5s. to 7s. 6d. for all calves that are reared to the satisfaction of the manager. The share system has numerous advantages. Let us consider one. A settler may not have the means to begin farming on his own responsibility, and if he has a young family who are unable to take part in the labour of the farm the difficulties are increased. The share system for this class of farmer is desirable, and if he makes a success of his opportunities he will soon acquire sufficient capital to farm his own land, and when his children grow up they will take a profitable part in its development. Should he be, however, unable to meet the financial requirements he can obtain assistance from the Agricultural Bank, a Government institution which advances 12s. in the £ towards improvements, and 10s. in the £ for stock, machinery, and implements. 5 per cent. interest is charged on the loan and repayment extends over twenty-five years.

In South Africa the share system should be very helpful, particularly as the dairying industry is in its infancy, and settlers are in great demand. Often we find that the best and most valuable agriculturists of a country have sprung from the labouring classes, and thousands of country-bred men who are struggling to-day would, if the opportunity were only given, become a great asset to the agricultural world.

The share system also provides education and guidance in the work of the farm, for it matters not how perfect a man might be in farm work in Britain, he must do in a new country what is best suited to the climate, soil, and market. At this juncture it will be of interest to show what capital is required to equip a 160-acre dairy farm in Queensland. The following is an approximate estimate based on official figures.

Crown lands at 30s. per acre—

Rent: First year's deposit	£6	0	0
Survey fees - one-fifth	1	18	0
Fencing—2 miles at £25 per mile (posts, 12 ft. apart, with three barbs)	50	0	0
Twelve cows at £6 per head	72	0	0
Young bull	10	0	0
Two horses at £22. 10s. per head	45	0	0
Three pigs (slips)	1	10	0
Plough, harrow, roller	10	0	0
Harness -	5	0	0
Swingle-bars and chains -	1	5	0
Tools	5	0	0
House	50	0	0
Milking-shed and bails, and yard	15	0	0
Dairy	15	0	0
Separator (30 gals.)	15	0	0
Dairy utensils	2	10	0
Cart (second-hand)	12	0	0
Clearing and grassing 10 acres (own labour)	30	0	0
	£347	3	0

Good milk cows will realise a profit of from 15s. to 22s. per month on a seven to eight months' milking season.

The official estimate could be reduced if the fencing and the house were constructed by the settler and his family. Further advantage could be taken perhaps in the use of a hired bull, and through the kindness of neighbours, who as a rule try to help each other. In reviewing the estimate, one must take into consideration that the farm would be practically under grass, only a small area being cultivated.

Blessed with a fine open climate "setting up house" on the land in Australia is very much cheaper than in Britain.

In colonial dairy farming there is a mine of wealth for the settler, but he must not think for one moment that the factories pay their suppliers big monthly cheques for milk and cream, without the money being won by industry and hard work. Every prospective settler should make up his mind to go without some of the comforts and luxuries of the homeland, and to put the best of his energies into the duties of the farm. When this is done success is a sure reward.

British Agricultural Co-partnership

Many systems have been advocated for the benefit of the British agricultural labourer, and smallholdings have been put forth as an inducement to keep the people on the land. Sufficient time has not yet been given to test the true value of the experiment. Much will depend on the productiveness of the soil, and the general suitability of the holdings for successful farming. Where these essentials are awanting difficulties of a serious kind will be encountered. There is one thing certain, that the united efforts of Britain are very urgently needed to improve the lot of the agricultural labourer and small farmer. He is being crushed out of the country, and one deeply regrets the withdrawal from their native land of thousands of the finest types of manhood and womanhood, who are migrating to the United States to be lost entirely to the Empire. Already

America claims to have about 3,000,000 British-born subjects, of which 400,000 are resident in Chicago. Those who for voluntary reasons are seeking new homes in our Colonies remain the valuable property of the nation that bred them, and their mission is one that commends itself to the average thinker. One of the evils of wholesale emigration may be found in the low wages and defective housing of the labourer. When one considers that some counties are paying from 12s. to 18s. per week to their farm hands, very poor inducement is held out to the country youth to follow in his father's footsteps.

In discussing the subject with the Hon. Edward Strutt, one of the best known and respected of England's progressive agriculturists, an opportunity was given to have the views of one so closely associated with the welfare of the farm labourer. Mr Strutt advocates that more small farms are wanted as well as large farms, and they should become the property of their tenants. It is distinctly in reason to say that a farmer and his family will give their best efforts to improve what belongs to them, and if they are deprived of that inherent and natural desire which is growing stronger each year, it becomes reflected in their work as farm labourers. It therefore follows that with the changed conditions of life which we are experiencing, and the objections raised by the worker, which no reasonable person wishes to dispute, there are very strong arguments in support of Mr Strutt's contention. This has been fully realised by Canada, and she has risen to the occasion. Denmark has conclusively proved that the man who owns his farm or his croft has a foundation for success, and it is his own fault if he fails to make the best use of it.

Mr Strutt argues that the next best step is co-partnership, and on this subject he speaks with the authority of one who has practised it with his employees for the past three years. The workmen on the extensive farms in Essex managed by Mr Strutt have a direct interest in the welfare of the estate, and in this way they are encouraged to work on lines that will be to their own financial advantage, and to the success of the undertaking with which they have become so closely associated. A bonus system is favoured in which some 150 employees participate, and this year over £600 will be distributed amongst them. Their earnings and the bonus can be invested in the farms, and they are paid a rate of interest equivalent to the dividend declared after the rent and all expenses have been met. Altogether the workmen have nearly £4,000 invested in this way, which speaks volumes for the scheme. In Mr Strutt's own words, the system has been an unqualified success, and he is extending it to the farms owned by the firm of Messrs Strutt & Parker, of which he is an active partner.

Winter Dairying

The success of Denmark in keeping up a continuous export trade in butter is envied in Ireland, and there has been much talk of winter dairying in that country. No doubt reforms are urgently required in Ireland, as in the Colonies, and the development of the margarine trade should bring this about. Immediately the difficulties in the path of progress are overcome, winter dairying will then be established. Irish butter needs levelling up, just as the exports of other countries are too mixed a quality to commend the full confidence of buyers and consumers. Improved methods, where improvement is most desired, and a system of classing produce as already recommended, would go a long way to raise the average price of Irish butter and encourage dairying all the year round. Some action is required to adjust the summer and winter prices for milk in Ireland, and certainly there is scope for raising the standard of dairy herds. The following tables, taken from a report of the Irish Department of Agriculture, show the income and expenditure on a five cow experiment to demonstrate the difference in the profits of winter and summer dairying.

Winter Calvers

Income	£	s.	d.	Expenditure	£	s.	d.	£	s.	d.
3,848¼ gals. new milk at average creamery price of 4.87d. per gallon -	£78	0	0	Hay and straw (including litter)	£12	10	11½			
3,078½ gals. separated milk at 1d. per gallon -	12	16	6	Roots	6	1	7			
1 ton of manure per month for each cow at 3s. per ton	4	10	0	Cake	6	16	6½			
5 calves at £1 per calf	5	0	0	Oats	9	13	5	£35	2	6
				Grazing—3 acres per cow at 10s. per acre				7	10	0
				Carting milk to creamery at ¼d. per gallon				4	0	2
				Milking				5	0	0
				Attendance				4	17	0
				Insurance at 1s. 6d. per cow per month				4	10	0
				Depreciation				5	0	0
				Interest on Capital				4	10	0
				Service of cows at 2s. 6d. per cow -				0	12	6
				[1] Balance (profit)				29	5	1
	£100	7	3					£100	7	3

[1] Profit per cow £5 17 0.

Spring Calvers

Income	£	s.	d.	Expenditure	£	s.	d.	£	s.	d.
3,413 gals. new milk at average creamery price of 4.68d. per gallon -	£66	11	0	Hay and straw (including litter)	£13	3	7½			
2,730½ gals. separated milk at 1d. per gallon	11	6	7	Roots	4	3	1½			
1 ton of manure per month for each cow at 2s. 4d. per ton	3	10	0	Cake	5	16	8			
5 calves at £1 per calf	5	0	0	Oats	5	1	2	£28	4	7
				Grazing—3 acres per cow at 10s. per acre				7	10	0
				Carting milk to creamery at ¼d. per gallon -				3	11	1
				Milking				4	15	0
				Attendance				4	10	0
				Insurance at 1s. 6d. per cow per month				4	10	0
				Depreciation				5	0	0
				Interest on Capital				4	10	0
				Service of cows at 2s. 6d. per cow -				0	12	6
				[1] Balance (profit)				23	4	5
	£86	7	7					£86	7	7

[1] Profit per cow - £4 12 11.

The report concludes thus: Does winter dairying pay? Yes. Which is the more profitable, winter or summer dairying? Winter.

CHAPTER VIII

CHEESE-MAKING

Its Science and Practice

CHEESE-MAKING is a very ancient branch of dairying, and in every country of the world there are varieties of cheese that may be called indigenous and *par excellence* in quality. Some two hundred and twenty have already been identified.

The chief honour is due to France for elevating cheese-making to an industry of great value and scientific importance. In that country about forty different kinds of cheese commend the attention of manufacturers, of which the following may be mentioned :—

- *Pressed Cheese.*
  - Cantal.
  - Gruyère.
- *Blue Veined.*
  - La fourme d'Ambert.
  - Le Gex.
- *Soft Cheese with Hard Crust.*
  - Port-Salut.
- *Double Cream.*
  - Gervais.
  - Bondons.
  - Malakoffs.
- *Unwashed Coats.*
  - Brie.
  - Coulommiers.
  - Camembert.
  - Neufchâtel.
  - Le Compiegne.
  - Le Troyes.
  - Le Saint-Florentin.
  - Le Langres.
- *Washed Coats.*
  - Pont L'Evêque.
- *Sheep's Cheese.*
  - Roquefort.
- *Cheeses made partly from Goats' Milk.*
  - Sassenage.
  - Septmoncel.

In Continental works on cheese-making it is interesting to note that the English product was introduced into

France from England by Henry II., who it is said had many varieties on his provision list.

In France cheeses are made from three qualities of milk, namely, whole milk, partly skimmed, and skimmed. This has a sound practical and commercial value, and to the householder it has very obvious economical advantages.

It will be observed in the list given that the manufacture of sheep's cheese is not omitted in France. In the Balkans, in particular, cheese may be said to be made almost exclusively from the milk of the ewe. In this part of the world the male progeny of the cow take the place of the horse in Western Europe, and the sheep is largely substituted for the cow. The writer has studied the manufacture of cheese in the Near East, and has sampled varieties of excellent quality. In some cases cheese is ripened in a loose condition in barrels and it is eaten in that way. In other instances the curd is cut into blocks which are matured in tubs and barrels of water. The sustaining properties of the cheese is very marked, and the Adrianople garrison owed much to this product. In the Carpathian mountains the natives make a hard-pressed cheese which is smoked in the huts. The quality is very good, and the cheese possesses wonderful keeping properties. Cheese made from the milk of sheep brings great profits. Some farmers earn up to £800 per annum from this source alone. The milking period of the Balkan ewes is astonishing, five months from the weaning of the lambs being quite usual, and the yield is large and of fine quality.

The milking breeds of sheep are small and comparatively lean, and the ewes respond to feeding in a wonderful way. Changing from a dry pasture of poor quality to a rich succulent pasture will raise both the quantity and quality of ewes' milk very rapidly. It should be observed that in hot dry climates where natural grasses of good quality are grown, the sun-scorched pasture is very nourishing, providing the nutritious elements have not been washed out by rain.

Goats, although very hardy and good milkers, have not fulfilled the wishes of the cheese-maker. They give a pretty good yield of milk and many continue in profit up to fifteen years.

Cheddar Cheese

As the manufacture of cheddar cheese claims the close attention of Britain and the Colonies, let us deal with the subject in a practical and comprehensive way.

The success of cheese-making is largely determined by three agents. Climate, which includes adaptability of country; intelligence, and cleanliness. On the farmer depends much of the success of the factory, for, without his care, the difficulties would be too great to bridge in the conversion of the raw material into a sound marketable cheese. Science and skill, combined with the most perfect equipment, are of little avail when impure milk is sent to the factory, and the dairyman must never lose sight of the grave responsibilities which devolve upon him. The day is fast approaching when cheese-makers of training and repute will accept the management of factories only on a guarantee that the milk supply, factory, and equipment are satisfactory. Too often a proud young spirit is crushed, and a promising future checked through faults and defects having to be faced over which the cheese-maker has no control. Let directors and those in authority give to the manager at least one privilege, namely, a free hand to reject all milk that is found to be unfit for manufacturing purposes.

Cheese-Makers.—Cheese-making is a branch of dairying which involves much careful training before the student can be entrusted with the management of a factory. Close observance is required in practice, and a knowledge of the elementary sciences helps to lay the foundation of a successful career. Without an earnest desire to reach a standard of excellence from the inception of his education, the cheese-maker will never be thoroughly capable of overcoming the difficulties which continually confront him. That keen attention and earnest study are imperative to a good name must be fully recognised by the cheese-maker, and precautions taken not to view his occupation with a feeling that the work is simple and a high standard easily reached. Losses have been suffered by the industry through this mistake, and complete failures amongst factory hands can be attributed to the same cause.

With the days of apprenticeship over, the young manager should be ever careful that his factory will have an educational value to the milk supplier, in cleanliness and management. While travelling in European countries as a Dairy Commissioner for the South Australian Government the writer had this excellent feature well illustrated, and nowhere perhaps was there a better example of the far-reaching influences of this class of education than in Scotland. At the Dairy Institute, Kilmarnock, the student is first taught to observe the dangers of uncleanliness, and throughout his training the evil effects are brought continually under his notice in a most impressive manner. He is made to realise that without observance of this law, his future as a butter and cheese maker is doomed to failure. The grounding in cleanliness finds expression in the spotless appearance of the dairies in Ayrshire, and many of the humblest and crudest places show that the foundation of success has been observed and established. The school, as the nucleus of the industry, is well patronised by the local cheese-makers, who seize the opportunity to perfect their knowledge and put into practice the tenets to which the Institute owes much of its worth.

Factories.—The principle of what has been written on the construction of a butter factory will apply with even greater importance to the cheese industry. The making-room should be the beau ideal of all that is clean and sanitary and should be "furnished" with the necessary appliances and nothing more. A pure atmosphere has a great deal to do with high-class cheese. The air is one of the controlling factors in the ripening of milk and in the flavouring of curd, and if contaminated from sanitary defects in the room or from outside sources, a heavy price has to be paid. A brand of cheese was known to the writer because of a faint coal-gas flavour which seemed to be inseparable from the quality. The factory was in the neighbourhood of a gas works, and the only remedy was to abandon the building for cheese-making and go farther afield where the atmosphere was pure.

Drains.—In hot climates cheese factory drains should be open to the atmosphere to ensure thorough cleansing. Closed drains are likely to cause trouble unless the system and the workmanship are of the very best.

Temperature.—This should be well regulated in the making and curing rooms. Any fault in the system of ventilation should be immediately remedied. Cold draughts or sudden falls of temperature are dangerous, particularly when the warm curd is on the rack, or during the early stages of ripening.

Equipment.—It is not expensive to properly equip a cheese factory, and there is no excuse for errors in this direction. Defective appliances quickly swallow up the proprietors' or shareholders' profits.

Vats should be of strong construction, of the best quality of metal, and free from seams of any kind. Many vats are woefully faulty, one common objection being the ridiculously small taps for the removal of the whey. A few minutes' delay at this stage in cheese-making may do irreparable damage to the quality of the cheese. The steam jacket should be regularly cleaned to prevent taints (see p. 433).

Knives. Care should be taken not to have the knives too small. Overlapping causes irregular cutting of the curd; injury follows, not only in the escape of fat in the whey, but uneven cooking produces a cheese defective in flavour and keeping properties.

Steam Pressure.—Precautions must be taken to ensure an even distribution of steam in the jacket. In some instances the heat is considerably higher at one end of the vat than the other, making a difference of from 1° to 3° in the temperature of the curd during stirring. Cheese-makers know the grave dangers of defective scalding.

Rake.—A wooden rake of medium weight is desired, and constructed so as not to damage the cubes. Heavy rakes cause cheese-makers and their assistants unnecessary toil. As breaking a tooth is not an uncommon occurrence, managers are strongly advised to effect repairs without delay, and thereby save injury to the cheese.

Curd Sinks.—Every factory should be equipped with a well-constructed sink or cooler. In hot weather the sink is indispensable for aerating and cooling the curd. Without this appliance it is impossible to combat the difficulties usually met with in the summer heat when milk is "fast," and taints are troublesome.

Mill.—The pegmill is favoured in preference to other makes. The belief that the pegmill bleeds the curd of its fat is not substantiated by fact. An objection to rival machines is that the clean-cut strips do not absorb the salt so readily as the rugged pieces from the pegmill, besides, a second and third cutting in most cases is considered necessary.

Thermometers.—The necessity for the use of accurate thermometers must not be lightly entertained by cheese-makers, as an error of 1° will reflect in the finished product. When tested with a standard instrument, many thermometers are found unreliable, the difference in some being as much as 7°. These thermometers are of a very cheap class, and ought not to be allowed into the possession of factories. Breakages are said to account for their purchase, but accidents seldom happen when proper care is exercised. If directors realised the danger of this false economy, they would take immediate steps to remedy the error. Two tested thermometers should be kept in every factory.

THE MILK SUPPLY

Influence of Soils.—Variation in soils and districts demands consideration in the making of cheese. Milk from pasture grown on chalky lands, and where the drinking water of cows is heavily charged with lime, will have a drying influence on the curd, and a neutralising effect upon the acid. To avoid error, it is found necessary to treat the milk at a lower temperature, as moisture is easily expelled in the cooking process. In handling milk from cows grazing on boggy land, and where the herbage is rank, the cheese-maker will meet with greater difficulties. Trouble may be experienced in getting rid of the excess of moisture, development of acid is slow, and the curd shows a liability to run together, which may cause bitterness in the mature cheese. It is advisable to ripen the milk well, cut the curd finer and of a smaller size, and heat steadily. By attending to these directions the cubes will contract more perfectly, causing the moisture to be better expelled.

Cheese-makers will require to be very careful when entering upon their duties in a new district.

Dangers of Preservatives.—Milk for cheese-making should be pure, sweet, and of normal quality. On no account should preservatives be used to extend the keeping properties of milk. Such a practice is sinful. Preservatives injure the natural ripening of the milk, check acidity in the curd, and cause a milky whey. The curd, in place of becoming firm and shotty, is soft and mushy, and the loss of butter fat is considerable. The flavour of the young cheese is generally insipid, and in many cases decomposition sets in, with the inevitable result that the product cannot be marketed with credit to the maker. In some countries, where cheese-making is extensively practised, losses are met with through the use of preservatives in "week-end" milk, the factories being shut down on Sundays. Injury through this cause, however, may be avoided by separating the milk for butter-making.

The following table illustrates the danger. The tests were made in comparatively cool weather, otherwise a number of cans would have registered "acid" readings: —

PERCENTAGES OF ACID IN MILK

Supplier.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
1	0.22	0.21	0.20	0.19	0.19	0.19
2	0.25	0.22	0.21	0.24	0.23	0.20
3	0.19	0.20	0.19	0.18	0.19	0.20
4	0.27	0.23	0.25	0.23	0.24	0.21
5	0.23	0.22	0.25	0.23	0.21	0.21
6	0.20	0.19	0.20	0.18	0.19	0.19

Sweet fresh milk should not have more than 0.19 per cent. of acid; but the foregoing table shows much higher percentages. Nos. 1, 3, and 6 are very desirable, care having been taken in the treatment of the milk, while Nos. 2, 4, and 5 clearly demonstrate want of attention on the part of suppliers.

It will be noticeable to the reader that the Monday morning's milk, with few exceptions, records the highest acidity tests, caused no doubt by Sunday's milk being included in the supplies.

It may be mentioned that the above tests were made from the milk after it was mixed.

A Dangerous Practice.—The purchase of inferior milk has become less restricted in parts of Australia, which is a most serious matter arising from competition and antagonism amongst factories for the supplies. One factory may rigidly enforce measures towards keeping up the standard of quality of their manufactured products, by buying only sweet and wholesome milk, while a neighbouring factory is striving, regardless of reputation, to add to their number of patrons by accepting faulty supplies. What follows this suicidal system? Heavy losses to the factory participating in the practice, and injury to the surrounding factories by a falling off in their returns. Not only does this happen, but encouragement is given to suppliers to become less careful in the treatment of milk, and instead of the factory extending its sphere of usefulness to a district, and being of educational value to producers, it becomes a source of evil to the whole industry.

Aeration of Milk

For cheese-making, milk that has been aerated properly and cooled is worth from 1d. to 2d. a gallon more than milk that has not been aerated. This the writer has proved by actual tests, and by the market prices of cheese. And might it be queried, why should this be? It has already been explained that aeration liberates bad gases from milk and cream, and the infusion of milk with air provides a most essential element for the ripening bacteria. We go to great trouble and expense to obtain high-class breeds of lactic organisms, but we often forget that they require very careful feeding, and very careful nursing in the cheese vat. The thread-worn story of splitting up the milk sugar into acid is of little importance when the organisms are deprived of pure atmospheric air. The cheese-maker should take very particular note of this, and he should insist on aeration of milk, explaining his reasons to suppliers. When healthy milk is charged with pure air, ripeness will proceed evenly, and consequently there will be uniformity of acid throughout the vat, giving to the curd its highest virtues and producing in the cheese enhanced qualities. Further, perfect acidity will add considerably to the weight of ripe cheese, and this is one important reason that aerated milk is worth from 1d. to 2d. per gallon more.

The following experiments were made in South Australia to demonstrate the value of simple methods of aeration :—

Test 1.—Using an ordinary corrugated cooler, three cans of freshly drawn milk of the same quality were treated as herewith explained :—

1 can containing 12 gals., aerated Sunday morning, showed 0.21 acid on Monday morning.
1 can containing 8 gals., cooled and aerated Sunday evening, showed 0.19 acid on Monday morning.
1 can containing 8 gals., cooled only Sunday evening, showed 0.23 acid on Monday morning.

After treatment the three cans were kept in the coolest place in the dairy.

The aerated milk was infinitely superior in taste, and was free from odours. The unaerated milk had a distinct cowy flavour, and was weedy. These results were verified by persons who were unaware of the distinctive treatment of the milk.

Test 2.—Four equal quantities were treated immediately after milking and tested twelve hours later.

Description.	Temperature.		Per Cent. Acid.	Condition.	Time Coagulating.
	Before Treatment.	After Treatment.			
1 can, aerated and cooled	94	74	.19	Sweet, good flavour.	40 hours.
1 can, cooled only	93	74	.22	Sweet with weedy flavour.	37 ,,
1 can, as milked	93	...	.255	Rank smell.	28 ,,
1 can, aerated only	94	89	.215	Flavour fair.	38½ ,,

Several other experiments were carried out, and showed in a marked degree the benefit of canvas covers for cans. The following examples are taken :—

Test 3.—Three suppliers were instructed to send to the factory daily three 10-gal. cans of milk. The selected farms were situated from nine to thirteen miles distant, for reasons that need no explanation. The instructions given were to cover two of the cans with calico, leaving the third uncovered. At the close of each evening's milking 5 gals. of milk were to be put in each can, but only one was to have its cover saturated with water. All the cans were to be kept under similar conditions until morning, when the remaining 5 gals. were to be added, and additional water poured over the covered can, the other two remaining dry as before.

On arrival at the factory the first day of the test, the nine cans registered the following percentages of acid :—

	Wet Cover	Dry Cover	Without Cover
First farm	0.20	0.22	0.23
Second farm	0.21	0.23	0.22
Third farm	0.20	0.22	0.23

On the second morning the acidity went down.

	Wet Cover	Dry Cover	Without Cover
First farm	0.18	0.21	0.21
Second farm	0.19	0.23	0.20
Third farm	0.18	0.20	0.22

TEMPERATURE OF MILK ON FIRST MORNING

	Wet Cover	Dry Cover	Without Cover
First farm	76° F.	82° F.	82° F.
Second farm	72° F.	80° F.	79° F.
Third farm	74° F.	78° F.	83° F.

SECOND MORNING

	Wet Cover	Dry Cover	Without Cover
First farm	66° F.	73° F.	74° F.
Second farm	71° F.	74° F.	73° F.
Third farm	61° F.	69° F.	79° F.

A couple of hot days were now experienced, causing marked variations in the acidity and temperature of the milk, which illustrated very thoroughly the advantages of the wet cover:—

	Wet Cover	Dry Cover	Without Cover
First farm	0.20	0.23	0.22
Second farm	0.20	0.22	0.24
Third farm	0.19	0.25	0.25

TEMPERATURE

	Wet Cover	Dry Cover	Without Cover
First farm	77° F.	84° F.	86° F.
Second farm	78° F.	88° F.	87° F.
Third farm	76° F.	85° F.	86° F.

Factory Manager's report of experiments with supplies of milk:—

"At the request of Mr G. S. Thomson I carried out an experiment on three supplies of milk at the Murrimbum Factory, South Australia, with the acidity apparatus, for the purpose of determining the effect of cooling and cleanliness in preventing the development of acid in milk. The four supplies were tested daily for a space of three weeks during November. Whenever a high acid reading was found in a supplier's milk, instructions were given to thoroughly cleanse and sterilise cans and utensils, and properly cool down milk immediately it was drawn.

"In conducting the test with the three cans, the milk in the can covered with wet calico had one to three points less acid, and the temperature, which was taken each morning, was from 1-4° lower in the covered can; the greatest difference in temperature prevailed when the weather was warm and sun hot. One supplier aerated a can in addition to cooling, when the percentage of acid was surprisingly low.

"An experiment tried apart from the above, with wet cover on an exceedingly hot morning, proved that evaporation and protection from the sun—afforded by wet cover—kept a can of milk 10° cooler than uncovered milk during a journey of two and a half miles.

"The results of these experiments have been so satisfactory that I now have the wet envelope system generally adopted by my suppliers, and, as they themselves say, it prevents risk of rejection and saves many a can of milk in a season."

Test 4.—Equal quantities of night's milk were measured into two suppliers' cans; after milking, one was aerated and the other left as drawn:—

	AERATED MILK.			UNAERATED MILK.	
Date and Hour.	Temperature before Aeration.	Temperature after Aeration.	Per Cent. Acid.	Temperature.	Per Cent. Acid.
16th November, 6.30 P.M.	88°	83°	0.20	86°	0.24

The test for acid was made at 6.30 on the following morning under similar conditions. The aerated milk was infinitely superior in taste, and was free from odour. The unaerated milk possessed a distinct "cowy" odour and a flavour of dandelion. In addition to being wholesome in flavour, the aerated milk is shown to have 0.04 less acid than the unaerated milk.

PROCESS OF MAKING BRITISH CHEDDAR CHEESE

Ripening of Milk.—Ripening of the milk takes place in the vat. In other words, it develops a degree of acidity that experience has shown to be necessary to the manufacture of cheese of high quality. Milk obtained from cows under uncleanly conditions will contain bacteria that may give rise to floating curd and other defects.

In the cool months of the year trouble has been experienced and losses sustained through the slowness of the milk to produce acid. The addition of a starter is attended with good results. Where a pure culture cannot be procured from a laboratory the starter may be prepared as follows: Put in sterile jars samples of the best factory milk, and keep at a temperature of 75° F., until coagulated into a weak curd. Select the sample that has the best flavour and is free from holes, and blend it thoroughly with a gallon of pasteurised milk. Place in a well-ventilated room, and keep the milk warm. When a pleasant acid flavour is present, and the milk slightly thick, the starter is ready for use. Fresh starters can be prepared by inoculating pasteurised skim milk with a quantity of the approved sample. As pointed out in a previous chapter, great care is necessary with starters, as contamination would lead to serious results in the manufacture of the cheese.

In many countries it is now possible to purchase starters of the best quality, and cheese-makers should not hesitate to make good use of the bacteriologist for purposes of this kind.

Adding the Colour.—As soon as the proper quantity of milk has been received, prepare the colouring by mixing the concentrated product with water. Thoroughly incorporate it with the milk by stirring from 3 to 5 minutes.

When milk is ripened by artificial means one must be careful that the colouring is added after the starter, otherwise streakiness in the cheese might follow.

Renneting.—In about an hour from commencement of artificial ripening, the milk will be ready for renneting, but it should be very carefully tested so that the exact time for this operation may be ascertained.

The Cup Test. This test is undoubtedly the most perfect indication of the condition of milk for cheese-making. To become competent in its use requires a good deal of practice, and the cheese-maker may congratulate himself when he is able to conduct the test successfully. The following is the process: Four oz. of milk from the vat at renneting temperature, say 84° F., are very carefully measured into a graduated glass, which is placed in a dish of water of similar temperature. One dr. of rennet (3.5 c.c.) is put into a cup that has been immersed in the water, also at 84° F. The milk is now added, and stirred rapidly for 10 seconds, the time of adding being noted on the second hand of a watch. Upon ceasing to stir, the forefinger of the right hand is put under the surface of the milk and quickly raised, this being smartly repeated until the first indication of coagulation is observed. At this moment the number of seconds is noted, which indicates the ripeness or acidity of the milk. If coagulation takes more than 22 seconds, the milk is too sweet; if less than 18 seconds, too fast. In some countries cheese-makers test the acidity by using pieces of straw and cork, which are made to rotate in the milk, and the time of coagulation is measured immediately the bodies stop. Such a test is not a reliable guide to renneting, as the period of rotation depends largely upon the surface and size of straw or cork used and the way of manipulating the "start." To attain proficiency in the finger test, perseverance is required.

The reason for giving close attention to renneting is because the acid in a great measure controls the chief characteristics of the cheese – namely, flavour, texture, and body. It further assists to expel the whey. The chief action, however, is to coagulate the valuable solids—fat and casein; sugar and albumen escape in the whey. The quantity of rennet to be added to milk depends on certain conditions. With rich milk more is required, also where lime salts are deficient, and in the treatment of "fast" milk. The rate at which rennet acts is governed by its age and strength, and by the acidity and temperature of the milk.

With all things normal, the best results are obtained when the rennet takes from 30 to 40 minutes to produce a firm curd; and cheese-makers should particularly recognise that the period of coagulation influences very largely the drainage and acidity of the curd and ripening of the cheese.

Before adding rennet, dilute with cold water. Hot water must not be used upon any account. Stir it thoroughly into the milk—5 minutes is usually taken for this operation. At the end of 10 minutes a little cream will usually be noticed on the surface of the milk; stir it down with the finger, and in cold weather cover the vat with a clean cloth to maintain a steady temperature.

When to Cut.—Mistakes in cutting too soon lead to a loss of fat, and with careless stirring small cubes of curd are destroyed and the weight of cheese reduced. By the use of the finger it can be ascertained when the curd is ready for the knives. A clean fracture with clear whey between is accepted as a reliable indication.

Process of Cutting.—Cutting is done by using the perpendicular knife first and working lengthwise, taking care not to overlap, but to keep the blade half an inch from the outer line of each cut. Care in cutting the curd adhering to the vat, and in entering the knife is often neglected. Crossing is the next operation, and at this stage a great deal of damage is often done. Enter the knife with handle slightly towards you and resting against the opposite side of the vat, the right or left hand blade touching the end ; cut steadily, and upon nearing your own side gradually slant the knife backwards, the bottom first coming into contact with the sides of the vat. In this position, cautiously draw the knife out of the curd and continue the process of cutting. Care is required to prevent an accumulation of particles of curd at the side of the vat next the operator. When this occurs, cut smartly in order to get the line straight. The horizontal knife is now used. Carefully enter, and cut from end to end, taking care to avoid overlapping. Do not turn the knife at the ends of the vat, and before removing give an additional cut around the sides of the vat, so that any large pieces previously missed will come under the influence of the knife. In cross-cutting enter the knife at the opposite side in a similar manner, push it flush with the side, and draw it towards you slightly slower than is done with the perpendicular knife. Overlap as found necessary to the size of curd required. Do not remove the knife until finished. Defective cutting will cause unequal cooking, and uneven ripening of the cheese, with cloudiness of colour and loss of weight. It stands to reason that smaller cut curd will be more thoroughly cooked than larger cut. In the larger cubes more whey will be retained, and with a high scalding temperature a skin will be formed round the cubes, preventing the escape of whey.

Stirring in the Vat.—Following cutting, the curd should be left for 5 minutes, afterwards stirred with the hands for 10 minutes. At the expiry of this time the curd will have firmed sufficiently to allow the rake to be used without damaging the cubes. Careful and efficient stirring is necessary, keeping the whole curd in motion and preventing lumps from forming in the corners and bottom of the vat. Stirring should be continued until the particles of curd are cooked so dry that when a handful is pressed for a few minutes it will fall apart.

Scalding.—The heating should be done gradually, at the rate of about 1 degree to every 4 minutes, and the time occupied from 5c minutes to 1 hour. The consistency of the curd as regards moisture is important, and should be governed by high or low temperature rather than any variation in the size of the cubes. In the fall of the year, when the period of lactation of cows is advanced, more heat is necessary to expel the moisture.

When the temperature reaches the desired degree, continue to stir until the particles of curd are firm and show no signs of sticking when pressed in the hand.

Settling in the Whey.—As soon as the stirring has ceased let the curd settle. In cold weather cover the vat with a cloth to maintain temperature. With proper management up to this stage the curd will bear evidence of acid, by its elasticity, and in 40 minutes to 1 hour threads of one-eighth to a quarter of an inch will be drawn on the hot iron.

Hot Iron Tests.—At this stage it will be well to explain how the measurement of acid is made. A small piece of curd is taken from the bottom of the vat and firmly squeezed in the hand to expel the whey. A bar of iron is heated, and the curd is brought into contact with the metal.

If the curd is matured and ready for removal to the cooler, fine silky threads of about a quarter of an inch will be drawn; if too sweet, they will break away short and thick. The length of the threads is in proportion to the acid in the curd. In conducting the test, it is necessary to be provided with a suitable iron. What is commonly used is more or less glazed on the surface. This condition prevents the acid of the curd acting on the metal, and misleads the operator at critical stages in his work. A bar of iron three-quarters of an inch square should be kept exclusively for testing, and after use, the metal should be thoroughly cleaned without bringing it into contact with any hard and damaging surface.

Drawing off the Whey.—When the test shows the required acidity, it is necessary to remove the whey without a moment's delay. Everything should be in readiness to receive the curd in the cooler, and nothing allowed to interfere with the manager's strict attention to duty. As the curd is smartly delivered into the sink, stirring is immediately engaged in to get rid of the excessive moisture surrounding the cubes. Remember it is only the free moisture that drains; all the stirring possible would prove ineffectual in drying the internal parts of the curd. From 5 to 7 minutes is sufficient to stir in ordinary cases, and during this operation care must be taken to prevent exposure of the hot curd to cold draughts of air in winter weather. Should the temperature be allowed to fall below 94° F., the development of acid would be checked, and an excess of moisture retained in the matted curd.

Matting.—The object of this is to assist the acid to effect a series of changes in the physical condition of the curd and to get uniform drainage. The curd is put to one end of the cooler, the surface made flat, and the whole mass covered with cloths in cold weather to ensure a warm temperature. At the end of 20 minutes uncover the curd and cut into squares of equal size, afterwards putting the blocks two deep with the back ones to the inside. At the expiry of 15 minutes turn again, placing the upper blocks below and the corner ones in the centre, making the squares three deep. Change again at the end of 30 minutes and test for acid. When an "inch and a half" is drawn the curd should have the desired characteristics, being flakey in appearance, silky to touch, and possessing a pleasant honey-like smell. If the curd is found to be soft, avoid piling deeply and do not mat at a high temperature. Satisfied with the iron test, remove the cover and commence milling. If the matting has been properly attended to, the temperature of the curd at this stage will be the same throughout, and the beneficial effects of good drainage illustrated.

Grinding the curd is done to enable the maker to thoroughly distribute the salt in the body of the cheese, also to liberate gas and expose the particles of curd to the air, which improves the flavour. Stirring occupies the cheese-maker's time for the next 10 minutes. The curd is now put to one end of the cooler to further mature, during which time it changes to a ripe, creamy flavour, and shows evidence of mellowness. In this condition the curd will liberate equal quantities of fat and moisture by pressing in the hand.

Salting.—The amount added will to some extent govern the time of ripening, as it has a checking influence on the acid. For a moderately long-keeping cheese 1 lb. to 50 lb. of curd is sufficient, but the richness of the milk, amount of moisture in the curd, acidity, and flavour have to be considered. Care must be exercised in the mixing of the salt. The curd is stirred until the preservative is dissolved; afterwards the whole mass is spread out to effect a fall in temperature. When it is brought down to about 75° F. the curd is hooped and taken to the press.

Pressing.—If the curd is too hot, fat will escape and a skim form on the outside, locking in the whey. If too cold, the particles of curd will not go together, and when the cheese is ripe the cubes will be readily seen. In press-

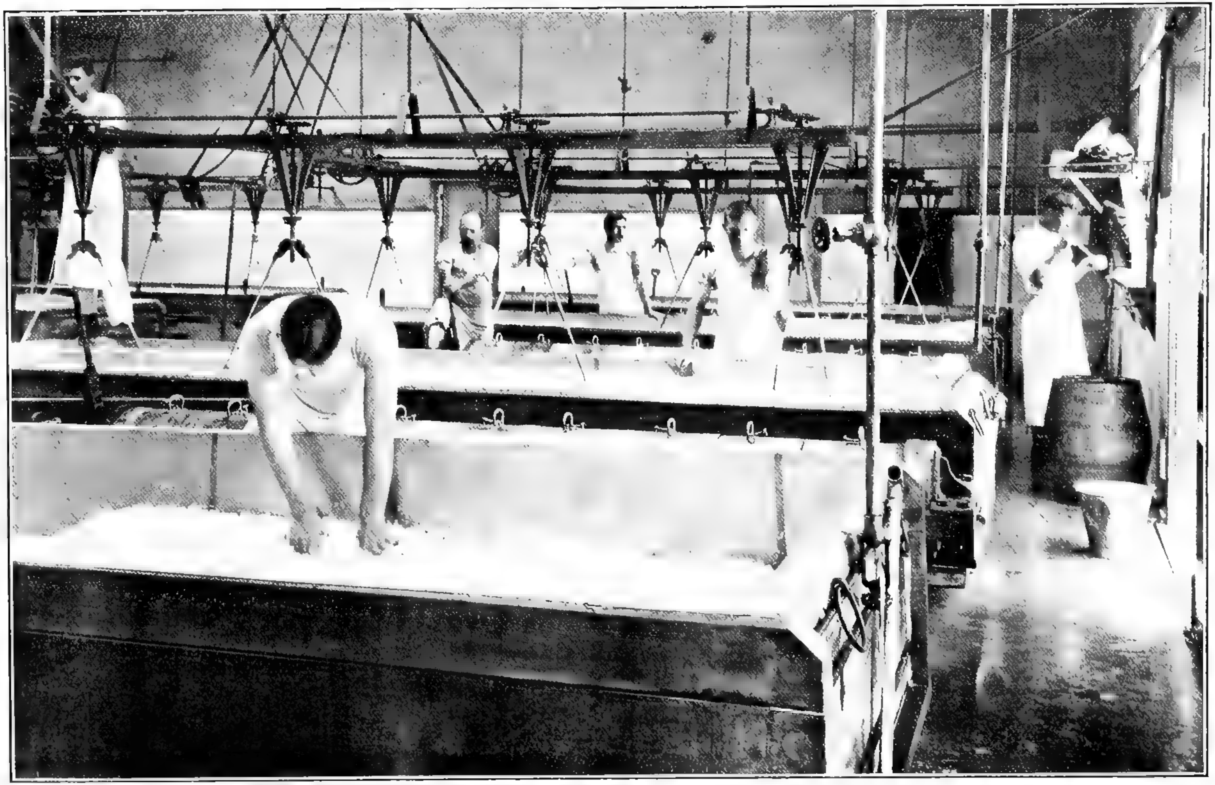


FIG. 78. Interior of Cheese-making Room, New Zealand Factory (Dept. Agric. Wellington).

ing, low power is applied at the commencement and the increase is made gradually.

Treatment of "Fast" Milk.—In the management of over-ripe milk the aim of the cheese-maker is to work the cheese so as to retard the fast-increasing acid. His first duty should be to apply steam immediately the full supply of milk is in the vat, and heat 2° below normal renneting. As soon as the necessary temperature is reached, a little more than the usual quantity of rennet is added to hasten coagulation, which usually takes from 10 to 20 minutes. The knives are brought into operation when the curd has barely reached a firm condition, and fine cutting is practised to avoid damage to the cubes, which would otherwise occur by retention of the moisture following a quick and high scald. After hand-stirring for a few minutes, the temperature of the curd is speedily raised to 105° or 106° F., while the whey is reduced by a steady escape from the syphon. The reason that large quantities of whey are not run off is to safeguard against too severe a check being put on the acid. As soon as acidity shows on the hot iron, and the curd is sufficiently firm, remove to the cooler, and stir a little longer than usual, but avoid a quick-falling temperature. In cases where the acid is in excess at this stage, wash the curd with clean water that has been boiled and cooled to 102° F. Stir and liberate the added moisture, and mat in a shallow layer. Cut into small blocks after 15 minutes, and pile lightly throughout the period of matting. Mill earlier, and salt with 8 oz. extra to the 100 lb. of curd.

Quick-ripening Cheese.—To produce cheese for early market allow more acid to develop in the milk, and add rennet in sufficient quantity to bring about coagulation in about 30 minutes at a temperature of 85° F.; lower the scald by 1° or 2° to increase the percentage of moisture in the green cheese. Draw the whey a little earlier, mature in the sink until the hot iron shows more than the usual measurements of acid. Add less salt, and do not press so heavily ; ripen at a higher temperature.

Slow-ripening Cheese.—Rennet at a low degree of acid, cut smaller, scald higher, develop less acid, add more salt, apply heavier pressure, and do not allow the temperature of the ripening-room to get high.

Faults in British and Colonial Cheddar Cheese

The writer will detail defects with causes and remedies, compiled from practical experience, and would urge cheese-makers to closely study each.

Sour.—This is attributed to the curd lying too long in the whey, too low a temperature of the curd after running off the whey, late salting, also chills at critical stages in manufacture. White moulds and incrustations on the outside of cheese will frequently indicate this fault.

Vinegar Taint.—The peculiar flavour is caused by a germ of the micrococcus group, which has also the property of curdling milk. Curd affected by this taint invariably contains much moisture. Remedy is, scald higher to reduce the moisture in the curd, and develop less acid before milling.

Herbage Taint.—This is pronounced in certain months of the year, when the milking stock feed upon taint-producing weeds, and are allowed too much lucerne. Remedy: Shift cows from one paddock to another, and change rations where possible, aerate milk on the farm, ripen milk thoroughly in the factory, cut the curd small, cook dry, stir well in the cooler, and mill fine. Store the cheese at a comparatively low temperature.

Water Taint.—Bad drinking water for milking stock will do serious damage to butter and cheese. Immediate attention should be given to this source of injury.

The use of a starter, prepared as suggested, and added to tainted milk, although advanced in acidity, will prove beneficial.

Bitterness.—Curd too long in the whey, sudden fall of temperature in cooler, check in ripening, and too low a temperature in curing.

Gassy Cheese.—When milk is observed to be gassy, bad-smelling, and slow to ripen, some change in the manufacture is necessary. The introduction of a starter would be attended with good to combat the evil organisms and increase the lactic acid. When the curd is firm, cut into large cubes, stir well with the hand, and scald slowly to 98° or 99° F. Run off the whey when the curd is drawing over one-quarter of an inch on the hot iron, mat deeply, and cut into large blocks. Pile so as to flatten the curd.

Weak, Pasty Cheese follows quick scalding of rich milk, which locks in the moisture. Remedy: Cut finer and scald steadily to 101° or 102° F. in the autumn and cold months of the year. Pasty cheese is often caused by the curd getting cold in the vat or cooler, producing a check on the acid and preventing the escape of the moisture. Salt sound curd in cold weather at a temperature not below 82° F. A weak cheese, when paled, gives a swollen plug, which cannot be replaced.

(NOTE.—Colostrum milk gives to curd a pasty consistency, and a difficulty is always met with in expelling the moisture from the curd.)

Dry, Crumbly Cheese.—Too much rennet, high temperature at coagulation, excess of acid and salt, curd hooped at too low a temperature and insufficiently pressed.

Hollow Ends may result from not pressing the curd sufficiently in the hoops and leaving the top flat instead of cone-shaped. Weak-bodied cheeses are more subject to this defect, and want of turning in the curing-room daily, adds to the danger.

Butter Fat Deposits may be caused by scalding at a high temperature and piling the curd too deep in the cooler. Over-stirring after milling, and salting when the curd is too firm are also hurtful.

Managers are asked to very carefully note that owing to a partial churning of milk while in transit to the factory, cream and particles of butter may be seen floating on the surface of the vat. If this is not skimmed off before renneting, it will mix with the curd after the whey is drawn, and produce deposits of liquid fat in the ripened cheese.

Soapy.—Cheese of this consistency, although prized by the makers and consumers alike, shows weakness of body, following insufficient acid.

Tough.—This complaint is recognised in cheese made from curd of low acidity at whey-running, and when salting has been done too soon.

Rough Texture.—Caused by excess of acid and delay in salting.

Holey Cheese.—This fault has its origin either in milk contaminated with gas-producing germs, or in a sweet curd badly aerated and pressed. In "sweet" cheese, the presence of round holes is an indication of unripened milk, and salting before enough acid had developed. Sweet curd that has not been aerated and properly pressed increases the possibilities of a holey cheese. Rugged holes may result from an irregular distribution of moisture and uneven temperature in the cooler, causing defective acidity. A sweet cheese is difficult to press, as the condition of the curd resists the binding influences of the machine. Heavy pressure is desirable, but care must be taken to obviate the danger of the cheese heaving in the curing-room. To prevent this do not press at a high temperature, and be careful in gradually applying the pressure, which should reach its full extent at the end of three hours. Particularly note that a sweet cheese is usually the result of drawing the whey too sweet, and adding the salt in advance of the acidity.

Open-bodied.—Settling in whey too soon, draining too sweet, piling matured curd too high.

Discoloration is caused by injurious bacteria acting upon the natural and artificial colouring in the cheese. Inferior colouring is strongly condemned. Keeping milk overnight at high temperatures will materially increase the risks of discoloration and decomposition. Moist curd and insufficient acid, favour the fault, and excess of acid when drawing off the whey is a source of equal danger. Curd piled too long in the cooler without turning has a bleaching effect on the cheese, but it must not be confounded with discoloration. Careless pressing should be avoided.

It might be noted that discoloration was some years ago one of the costliest defects in British cheddars, and it is to Professor Drummond, of Kilmarnock, that credit is chiefly due for the eradication of the fault. It was he who introduced the starter in Scotland, and, in the face of considerable opposition and jealousy, ably demonstrated its great worth to dairying. Professor Drummond's labours in this direction alone have proved a source of income to cheese-makers.

Bleeding or Leaking.—When moisture is noticed running from the cheese in the ripening-room, it indicates either over-ripe milk or too much acid in the curd. Acid milk or curd also makes cheeses of a dry and mealy texture, and poor in butter fat. What is known as acid-cut cheese is the result of similar mistakes. Leaking is also caused by excess of acid, or in other words, the making has not been kept in advance of the acidity. When the acid has developed to a certain extent, the moisture cannot be expelled in the later stages of manufacture.

Cheese Poor in Fat.—Piling curd too deep, and too much pressure and salting at a high temperature, give rise to loss of fat in the sink and press. Salting is recommended at temperatures not lower than 82° F., and not higher than 86° F. (See "Losses in Fat.")

Old Milk.—Quantities of old milk are sent to cheese factories, and the accumulation of fat frequently seen in the press would be reduced if the supply were delivered in a fresh, sweet condition.

Colour—High and Irregular.—Some brands of cheese are coloured to excess, damaging the properties of the cheese. A medium shade is recommended. Salt, not properly mixed in the body of the curd is chiefly responsible for uneven colour.

Cracking and Mouldy Cheese.—Over-acidity will cause cracks on the outside. Bathing the newly-pressed cheese in hot water at a temperature of 135° F. for one minute will toughen the skin. White moulds and mites on the surface indicate too much whey; blue moulds show a healthier product. Where damage is caused by these fungi, cleanse the curing-room without missing a single bit of structure. It is recom-

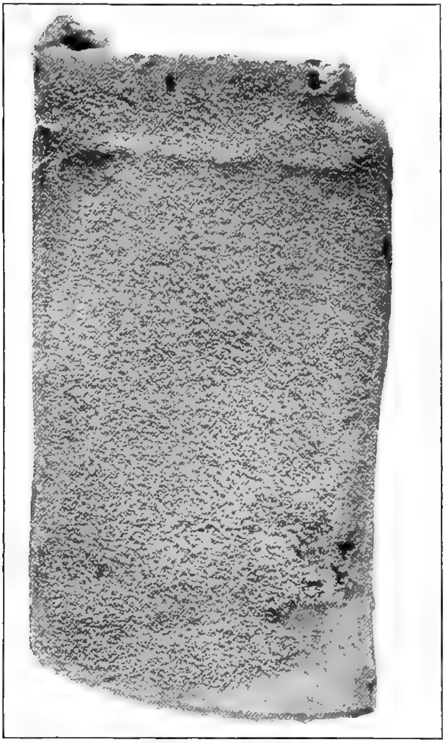


FIG. 79. Moulds on Cheese (Thomson).

mended to scrub with a cheap disinfecting mixture, afterwards burn sulphur in the room, and finally spray with a 10 per cent. solution of formalin. Ventilate thoroughly, and admit light. Sponge the mouldy cheeses with hot water containing a little ammonia. Attend to turning daily, to allow uniform evaporation, and place the cheeses so as not to touch each other. It might be mentioned that white mould indicates an excess of whey.

INFLUENCE OF MATURED CURD ON THE QUALITY OF CHEDDAR CHEESE

The quality of cheese made from sound milk depends on the maturing of the curd in the vat and cooler—that is to say, the development of acid and the texture of the raw product throughout the process of manufacture. To produce choice cheese, it is necessary to allow the acid to develop steadily, and not to hurry the work at any stage from the time the milk is renneted until the curd is ready for the press. If this is not attended to, the cheese will be pressed in an immature state, so to speak, and this grave mistake cannot be rectified in the curing-room. Sufficient time must be given for making if a good article is to be turned out. It is evident that many colonial makers are not giving the necessary hours to the practical work, as illustrated by the absence of the fine mellow flavour in ripe cheese. For a similar reason the true characteristics of well-matured cheese quickly fade when it has been cut up and exposed to the air. Based on the writer's experience, managers are recommended to give at least five hours, and not more than six, to the manufacture of cheddar cheese.

FACTORY JUDGING OF CHEESE

A most important element in the cheese-maker's education is his ability to identify a flavour in cheese, and to know its influence on the quality of the product, whether useful or injurious, vegetable or bacterial, where it originated, what favoured its action or development in the milk or curd, and what should be done to foster, arrest, or destroy it.

The value of cheese chiefly depends on the purity and attractiveness of flavour, and we acknowledge the efforts of science in assisting us to recognise by taste, smell, and appearance the cause of many damaging features in its quality. In the process of ripening, a knowledge of the changes is essential, and to test cheese at various stages of maturing and place them on the market at a time when the greatest gain will be effected, adds very considerably to the success of the manager and factory. It frequently follows that a defective making of cheese is at its best at an early period after manufacture, and every day following, its value decreases, and may fall to a very low price before removal from the factory. It is a grave error to be guided by time in the marketing of cheese, and more especially when a record has not been kept of the chief features in manufacture.

Managers would find it profitable to enter in a special cheese-book a number of headings similar to the copy given, and it is suggested to cheese-makers to discriminately pale their supplies at intervals, and ac-

ILLUSTRATION OF CHEESE RECORD

Date Manufactured.	Temperature of Making-room.	Gallons of Milk Used.	Time of Ripening.	Second Test or Acid Test.	Quantity of Colouring Used.	Temperature of Milk at Time of Renneting.	Quantity of Rennet Used.	Time when Added.	Time of Coagulation.	Temperature Heated to.	Time of Heating.	Time Settled in Whey.	Lb. of Curd.	Quantity of Salt Added.	Time of Salting.	Temperature of Curd at Pressing.	No. of Cheese.	Temperature and Moisture of Ripening-room.	Remarks.
			Min.	Sec.	Oz. dr.	F.	Oz.	A.M.	Min.	F.	Min.	Min.		Lb. oz.	P.M.	F.		T. M.	
:	...	170	60	19	2 5	85°	6	9	40	100	60	45	175	3 6	2	73°	10	60°	Put into hoop rather acid.

quaint themselves with the condition of those approaching the marketing stage. A cheese of first-class quality is distinguished by its rich and full flavour, solidity, freedom from holes, and discoloration. In testing, be careful that the plug does not rub against the rind, and a plug from a choice cheese should appear larger than the hole from which it came.

CHARACTERISTICS OF CHEESE

On this subject the writer has been in communication with the Departments of Agriculture in Canada and New Zealand, also the British Dairy Institute, England. The information received, which is herewith given, will prove of value to factory managers generally.

Canada

Cheddar Cheese—Descriptive of Flavour

Nutty: A rich, creamy, desirable flavour.

Sound: Denoting good keeping quality.

Fruity: Resembling fermented fruit, cider, or some kinds of wine.

Weedy: A flavour imparted to cheese by turnips excessive clover feeding, etc.

Descriptive of Body and Texture

Close: Without fractures or openings.

Silky: Showing a fine smooth texture when rubbed between the fingers.

Open: Showing rough, irregular holes.

Weak: Too soft.

Mealy: A rough, crumbly texture.

Acidy: Showing signs of too much acid and bleaching the colour.

Sour: Excessive acidity with free moisture.

Descriptive of Colours

White: Natural colour.

Pale: Slightly artificial colouring.

Colour: Export standard for colour.
High Coloured: Specially prepared for certain markets.
Mottled: Unevenness in the colour.

The foregoing applies only to cheddar cheese; the manufacture of stilton cheese is not carried on in Canada.

Off Flavour—Description.—This term is frequently applied in a general way to a variety of bad flavours, but it more properly refers only to the well-known characteristic flavour which indicates early deterioration in the cheese. It occurs most frequently during the hot weather, but does not usually become noticeable until the cheese begins to "break down."

Cause.—The so-called "off flavour" is of fermentation origin, and is the result of the milk being contaminated by filth in some form or other, and the cheese being cured at too high a temperature. It is only in extreme cases that cheeses go "off flavour" when they are cured at a temperature not exceeding 65° F. If there has not been sufficient acid in the curd, this defect is more liable to appear.

Means of Prevention.—Greater care and attention to cleanliness in the handling of the milk, proper development of acidity in the curd, *and control of the temperature in the curing-room* so that it will not go above 65° F., are effective means for preventing "off-flavoured" cheese.

"*Acidy*" *Cheese—Description.*—Some distinction is usually made between different degrees of sourness, and cheeses which are only a little mealy in texture and more or less faded in colour are called "acidy" or "acid cut." A plug from a so-called acidy cheese has a rough, "furry" surface, and does not show the smooth, bright appearance and semi-transparency which is characteristic of strictly finest cheese.

Cause.—As a rule "acidy" or sour cheeses are made from over-ripe milk, but it does not follow that all cheeses made from such are unavoidably "acidy." The trouble arises when too much acid is developed in the curd before it has been made sufficiently firm, or properly "cooked," to use a common though erroneous expression.

Again, if the whey is all removed while the curd is still in this soft condition, it is difficult to expel the surplus whey, and the result is apt to be a tender-bodied cheese, showing more or less signs of acidity.

Means of Prevention.—The remedy for "acidy" or sour cheese is to get rid of the whey more quickly, so that the curd will be firm enough before the acid develops. The curd should have a slightly elastic or springy character by the time it begins to "draw" on the hot iron. This result may be accomplished by cutting the curd finer, and by running off a portion of the whey as soon as the heating is finished or even before that stage has been reached in extreme cases. Vigorous stirring and continuous removal of the whey should be followed as the necessities of the case demand, but on no account should the whey be wholly removed until the curd has acquired the desired firmness and elasticity. It must be remembered that when the curd has to be handled in the foregoing manner there is considerable loss in yield. The necessity for doing so should be avoided by having the milk in a sweeter condition.

"*Fruity Flavour*"—*Description.*—The term "fruity" has been applied to a peculiar sweet flavour of very pronounced character which is frequently found in cheese. It has a strong resemblance to the odour of fermented fruit, certain kinds of wine, etc. It is found in the cheese from different sections of the country and during the different periods of the season, but does not appear to bear any relation to other qualities in the cheese. It may run through the output of a factory for several weeks, but usually its appearance is intermittent, and only certain days' make or particular batches are affected.

Cause.—The specific cause of this peculiar flavour has not yet been clearly determined, although efforts are being made in that direction. Sufficient is known, however, to justify the conclusion that it is of bacterial or at least fermentation origin, and not due to the effect of any kind of feed, as was supposed.

Remedy.—Without more knowledge concerning the cause of "fruity" flavours, it is impossible to do more than make some suggestions regarding a remedy. As it is most likely the result of the milk being contaminated in some manner, special efforts should be paid to the cleaning of the whey tank if the whey is returned in the cans.

British Dairy Institute

Cheddar Cheese—Flavour

Clean: Free from peculiar flavours, which in most cases are originated by taint-producing bacteria in milk, or by reason of the milk having been exposed to tainted substances.

Tainted Cheese: From tainted milk.

Off in Flavour: Cheese possessing wrong flavour.

Sweet: Cheese in which insufficient acidity has been developed.

Sour: Cheese possessing an excess of acidity.

Mild: Term applied to a cheese that does not possess a very full or pronounced flavour.

Texture

Loose Textured: Not solid and close, showing air spaces, and appearing granular, much moisture present, not sufficiently consolidated; without body.

Close Textured: Solid and compact, free from a granular appearance, and without excess of moisture, free from air spaces.

Hard: Cheeses that do not respond to pressure by the fingers, usually due to want of moisture.

Soapy: Too soft, and without body (for want of acidity).

Weak: A general term applied to all cheese that is made insufficiently acid.

Rough Textured: Not silky and buttery, not melting freely on the tongue, showing a grittiness.

Short: Too granular.

Other Characteristics

Acid: Sour, over-acid, usually made from sour and over-ripe milk.

Pale: Natural in colour.

Coloured: Artificially coloured throughout.

Fine: Cheese of best quality.

Medium: Cheese of medium quality (not referring in particular to the percentage of fat contained).

Lower Grade: Cheese badly made; of little value.

Heated: Cheeses that have been exposed to high temperatures in curing.

Blown or Puffy: Distended, usually noticeable in weak cheeses.

Green: Not matured.

Ripe: Matured.

Over-ripe: Matured too long.

Spring Cheese: Cheese made from milk produced from dry fodder in spring. It is not of great value.

Grass Cheese: Cheese made from milk when cows are out on the pasture (May to September).

New Zealand

1. Terms relating to parcels or lines:—
    a. Good; fair, irregular, or lacking in uniformity; poor, very poor.
2. Terms relating to flavours:—
    a. Same terms as used in 1.
    b. Mild, nutty, clean, rich.
    c. Irregular.
    d. Poor.
    e. Should be cleaner; should be more regular.
    f. Inclined strong, bitter, fruity, turnipy, rancid, off flavour, strong and unclean.
3. Terms relating to body and texture:—
    a. Close, firm, solid, meaty, waxy.
    b. Open or porous, loose, weak, sticky, pasty, salvy, mushy, raw, or showing ragged openness, show-

  ing fish-eyes; showing sweet-holes; showing pinholes.
- *c.* Stiff, corky, leathery, harsh, not broken down, too green.
- *d.* Showing excessive acidity, short, brittle, mealy, lumpy, granular, greasy.
- *e.* Flaky, flinty-break, fine or silky.

4. Terms relating to colour:—
   - *a.* True, straight, bright, uniform.
   - *b.* Acid cut, streaky, mottled, shows old curd, dull, should be brighter, should be more transparent, dead.

5. Terms relating to finish:—
   - *a.* Cases neat and attractive.
   - *b.* Cases should be bound with hoop iron.
   - *c.* Timber not dressed.
   - *d.* Timber green.
   - *e.* Branding smudgy; brand not sufficiently impressed.
   - *f.* Ends cases split, cases dirty, cases soiled.
   - *g.* Battens too short for cheese.
   - *h.* Cheese mouldy.
   - *i.* Rinds cracked or greasy.
   - *j.* Bandage wrinkled or not neatly trimmed.

Ripening-Room.—Ripening of cheese means the changing of insoluble constituents into soluble albuminoid bodies. New cheese is very indigestible because the casein has not had sufficient time to come under the full influence of the ferments that mellow and mature the cheese. Temperature is an active agent in assisting this valuable change. High temperatures hasten ripening, and if the heat is excessive the cheeses will bleed, and become hard and dry. Ripening rooms should be kept moist, and to ascertain the humidity the use of a hygrometer is recommended. The buildings should be protected as suggested on pp. 33 and 34.

POOR MILK AND CHEESE-MAKING

Kilmarnock Experiments

The illustration clearly demonstrates that poor milk, or milk that has had the fat abstracted, produces cheese of reduced weight, and Professor Drummond explains that the general quality is awanting in all cases where milk is impoverished.

The following tables show important features of the experiment :—

Weight of Milk Used.	Fat Contents of Milk.	Weight of Curd at Salting.	Weight of Curd after Pressing.	Weight of Cheese 10 Weeks after Making.
Lb.	Per Cent.	Lb.	Lb.	Lb.
500	0	40	32	28
500	1	46	38	37
500	2	52	46	43
500	3	54	48	46
500	4	56	52¼	50
500	4.7	59	55½	53

Milk containing 1 per cent. fat against 0 per cent. gave an increase of 9 lb. of cheese.

Milk containing 2 per cent. fat against 1 per cent. gave an increase of 6 lb. of cheese.

Milk containing 3 per cent. fat against 2 per cent. gave an increase of 3 lb. of cheese.

Milk containing 4 per cent. fat against 3 per cent. gave an increase of 4 lb. of cheese.

Milk containing 4.7 per cent. fat against 4 per cent. gave an increase of 3 lb. of cheese.

500 lb. of milk containing 0 per cent. fat against 500 lb. of milk containing 4.7 per cent. fat gave a reduction of 25 lb. of cheese.

Acting upon instructions from the writer, six South Australian factories kept a record of the weights of large and small cheeses from the date of manufacture until the day of their removal from the curing-rooms.

The following are the losses in shrinkage :—

A. Lost 4.6 percentage of moisture from 33.12 lb. cheese in 21 days, and 5.97 per cent. from 20.8 lb. cheese in 21 days.

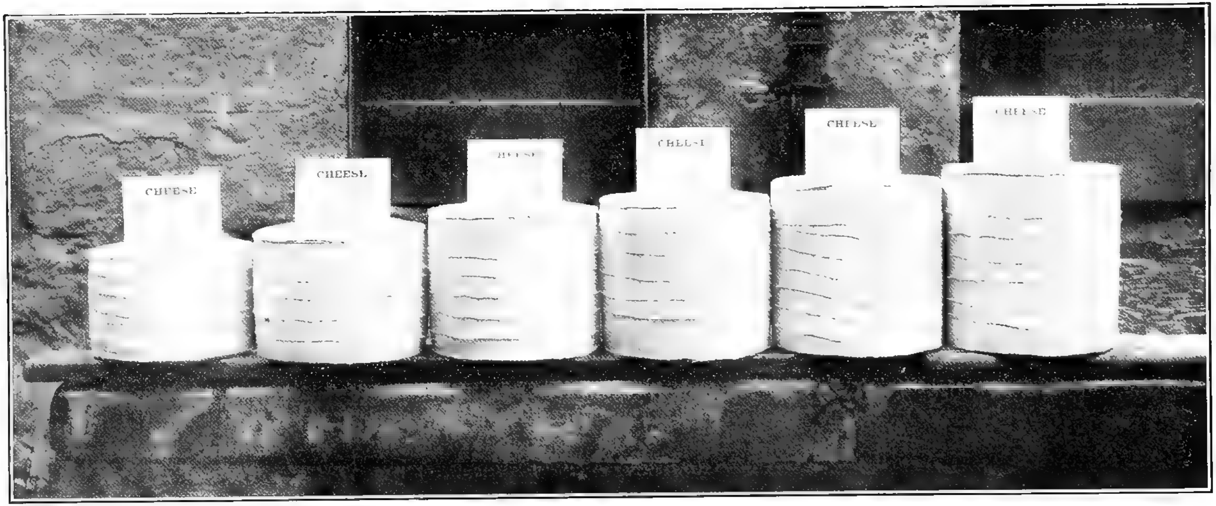


Fig. 80.—Cheese Experiments conducted at the Dairy School for Scotland by Professor R. J. Drummond.

*B*1. Lost 7.15 percentage of moisture from 69.40 lb. cheese in 35 days.

*B*2. Lost 4.86 percentage of moisture from 75.80 lb. cheese in 32 days.

*C*1. Lost 5.46 percentage of moisture from 41.00 lb. cheese in 21 days, and 8.33 per cent. from 11.60 lb. cheese in 21 days.

*C*2. Lost 5.61 percentage of moisture from 40.00 lb. cheese in 21 days, and 8.70 per cent. from 10.15 lb. cheese in 21 days. Average loss, 5.51 percentage of moisture from 51.8 lb. cheese in 26 days, and 7.6 per cent. from 14.1 lb. cheese in 21 days.

LOSSES IN FAT—IMPORTANT CAUSES

Cheeses poor in butter fat can be attributed to many causes,—viz., breed of cattle, feed, mixing cold and warm milk, preservatives, watered milk, inferior rennet, uneven cutting, careless stirring of the curd, rapid development and excess of acid during cooking, cooking too rapidly, and at too high a temperature, hooping at excessive temperatures, and quick and heavy pressing.

Breed of Cattle.—As previously explained, certain breeds of cows are better adapted for cheese-making than others, because of the smaller globules of fat in their milk and heavy yield. The Ayrshire fulfils the requirements of the cheese-maker exceptionally well; likewise are the Shorthorn, Friesian, and Holstein well suited. The Jersey is not credited with the same worth, as the fat globules are large and escape readily in the whey, thereby impoverishing the cheese of the most valuable constituent.

Feed.—The milk of the Jersey is made more unprofitable, as grass feeding predisposes to soft fats, rendering their loss in cheese-making greater. Dairy farmers will find it necessary to study this question, and by an alteration of the present methods of farming, feed their milking stock to encourage the production of harder fats.

To prove that excess of acid causes the escape of this valuable constituent of cheese, the following figures are taken from an experiment which the writer conducted :—

Fat in Milk.	Fat in Whey from Curd after Salting.	Fat from Press.	Acid at Pressing.
Per Cent.	Per Cent.	Per Cent.	Per Cent.
A—3.5	0.3	0.8	0.85
B—3.4	0.9	1.2	1.95
C—3.6	2.1	1.2	0.90
D—3.7	2.1	3.2	1.00

The percentage of acid at pressing is high in B, C, and D, while the fat percentages are correspondingly high in the curd before and after pressing.

It is reasonable that fat will escape when the particles of curd become speedily contracted, a condition which takes place when there is a rapid development of acid or a quick and high temperature. To avoid these heavy losses in butter fat, the "secret" is to have the milk as near as possible to a fixed acidity, which can be readily ascertained by the cup or alkaline tests, and by gradual and careful cooking.

Mixing Cold and Warm Milk.—Quantities of cream are frequently seen floating on the surface of the whey in the vat. One cause has been given, but it may also arise from mixing the evening's cold milk with the morning's supply, and sending it to the factory with the cream in a clotted condition.

DANGER OF HIGH TEMPERATURES

The following test proves the effect of a high temperature upon the fat percentages in curd.

Four hundred and seventy-eight gallons of milk were treated, and all practical and scientific tests were applied. The quality and purity of milk were high. After the usual care in aerating the milk by a circulation of cold water in the jacket of the vat, the temperature was raised to 88° F., the cup test showing twenty seconds. The alkaline test was next applied, and repeated at different stages in manufacture. Work proceeded along the usual lines, the scalding temperatures being, however, allowed to run to 104° F.; afterwards the curd was left to settle, when a sample of whey was taken for fat analysis.

Additional samples of whey were taken from the strainer and analysed. The time of removing the curd to the cooler was based on scientific tests. With an advanced acid in soft and mushy curd, smell and feel by hand give little or no indication of its condition, and are decidedly unreliable with rich and changeable milk. A more useful practical indication of the condition of the curd is ascertained by the grit on the teeth. Although the writer has not previously advocated this, he feels confident that an experienced cheese-maker who is at first guided by the hot iron and alkaline tests, can estimate by this means alone the measurement of acidity.

Immediately after the curd was transferred to the cooler, thorough stirring was conducted for five minutes: afterwards the curd was allowed to mat for a further period of twenty minutes, and then cut. The square blocks were arranged in rows of two deep, and milling followed immediately the desired acidity was reached. The curd was salted at the rate of 2 per cent. The second cheese was made on the same lines, but cutting was not done so finely and the scalding temperature was only raised to 99° F. The reason for this was to compare the difference in losses of butter fat in the whey.

ABSTRACTS FROM RECORDS OF MANUFACTURE

No.	Seconds Test.	Temperature of Milk at Time of Renneting.	Time of Coagulation.	Temperature Heated to	Time of Heating.	Time Settled in Whey.
			Minutes			Minutes
1	19	86° F.	30	104° F.	40	15
2	20	86° F.	35	99° F.	45	25

Acidity Test.—Milk before renneting, 0.19 and 0.20; whey before breaking, 0.15 and 0.14; whey when drawn, 0.16 and 0.18; curd whey when taken to cooler, 0.20 and 0.28; liquid from press, 0.7 and 0.5 per cent. of acid.

PERCENTAGE OF FAT IN WHEY

	Before Running Off.	From Strainer.	From Press.
No. 1 cheese	0.30	0.35	0.50
No. 2 cheese	0.25	0.25	0.35

The excess of fat in No. 1 is owing to too fine cutting of the curd and high and rapid scalding.

Inferior Rennet.—Inferior rennet is responsible for serious damage to cheese. When used there is a feeble coagulation of the milk. Difficulty and failure in cutting are experienced, causing heavy losses of milk solids. The quality of the cheese suffers increased injury by the irregular cooking of a soft, bodyless curd.

Rennet should be kept in darkness, as light lowers its coagulating properties.

CHEMICAL OR ALKALINE TEST

Explanation of the Apparatus.—The large bottle shown in the sketch contains a solution of caustic soda of a standard strength (*i.e.*, 1 c.c. will neutralise 0.01 grm. of the acid of the milk). The mouth of this bottle is closed with a rubber stopper, through which two glass tubes pass. The one on the right is the air tube, which does not come into contact with the caustic soda solution. The tube on the left conveys the solution to the graduated burette. The smaller bottle on the right contains caustic soda and phenolphthalein, and through the short tube air enters to be purified before it passes to the bottle containing the caustic soda solution. When the caustic soda and phenolphthalein mixture becomes pale, a fresh supply is necessary.

The burette is marked with 200 divisions of 20 c.c., or 10 divisions to the c.c. A pinch-cock is affixed to the glass tube communicating with the burette, and another at the bottom for admitting the caustic soda solution to the milk to be tested. The top of the burette is closed with an indiarubber stopper to prevent the admission of air when not in use.

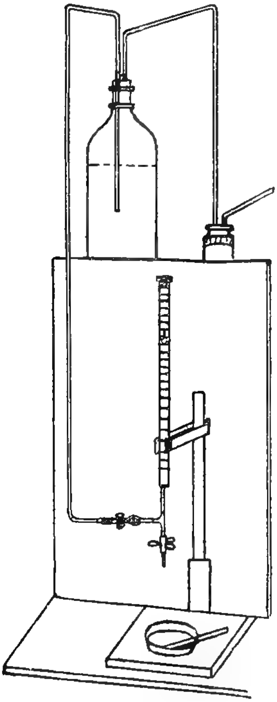


FIG. 81.—Acidity Apparatus (Thomson).

Manipulating the Test.—By means of a glass pipette 10 c.c. of milk are taken from the vat and run into a porcelain dish as seen on the stand. Into this is put three drops of phenolphthalein from a stoppered bottle. (Phenolphthalein is the liquid used as an indicator to show when the acid in the milk is neutralised by the soda from the burette.) After stirring with a glass rod, the porcelain dish is placed directly under the burette, and with the left hand the pinch-cock is opened and the caustic soda allowed to drop into the milk. With the right hand the operator stirs the mixture. If ordinary sweet milk is being tested, a red coloration will be momentarily visible, disappearing on stirring; but when a faint pink colour remains, the reading of the burette must then be taken. Care is required with the pinch-cock, as a few drops of soda in excess of the proper proportion would seriously misguide one in the time of renneting. When the number of c.c. has been counted, the pinch-cock is gently pressed to admit fresh soda to replace that which has been removed. A float in the burette makes the determination of the reading an easy matter.

If the loss of soda shows nineteen divisions, the percentage of acid in the milk is 0.19. If, on the other hand, twenty-five divisions are required, the lactic acid would be 0.25 per cent. Milk as it comes from the cow contains about 0.19 per cent. of acid, and to make cheese from so low an acidity as this without the assistance of a starter would be a grave mistake. But we rennet milk in cool weather with 0.20 per cent. and 0.21 per cent. of acid, with results which have already been explained. With the test as a guide, the cheese-maker would not add the rennet until he had a reading not lower than 0.22 per cent., but if it were 0.25 per cent. he would immediately rennet and make alterations throughout the making process to effect a check upon the quick-forming acid. Employing the apparatus at the pressing of the curd, excess of 1 per cent. of acid in the whey would indicate over-acidity.

Fixed rules in the application of the test cannot, however, be made; but from a little experience the cheese-maker will readily determine the exact quantity to develop to suit his district and climate.

Detecting Acid Preservatives in Milk.—As the active ingredients in a preservative consist very often of the acid of borax, the alkaline test can be adopted as a means of detection. Unadulterated milk will usually taste sour when it contains 0.35 per cent. of acid, but if an acid preservative has been added the milk may become thick, and yet remain sweet to smell and taste. By the application of the test, and if the reading shows 0.35 per cent. or over and the milk imparts to the taste no perceptible acidity, in all probability it has been treated with an acid preservative, and is certainly useless for cheese-making.

Milk from cows suspected of giving trouble in cheese-making through illness or improper feeding should be submitted to the test. It is not uncommon to find a low acid reading with unhealthy animals, and a high reading when the cows are fed on certain foods. Suppliers' milk can be individually examined on arrival at the factory, and when an excess of acid is determined suggestions for the future treatment of the milk should be given.

When stringy, floating, or badly-flavoured curd is causing trouble, a supply of faulty milk may be suspected. An examination is conducted in the following manner: Thoroughly steamed pint glass jars are three-fourths filled with suspected samples of milk and correctly numbered. The bottles are placed in a tub of warm water until the temperature of the milk reaches 98° F., when it is renneted with 10 drops of rennet. Special caution is necessary in using the thermometer, which must be thoroughly cleansed after taking the temperature of each lot, and stirring in the rennet requires careful attention, otherwise pure samples of milk might become contaminated. When the milk has coagulated, the curd is cut and the free whey removed. After twenty minutes more, whey is poured off, and the temperature of the water surrounding the jars is kept at 98° F. for the next twelve hours, to give the curd time to ferment. Each jar of curd is now cut with a sharp knife, and carefully examined for holes, sponginess in texture, and bad odours. The mouth of each jar must be covered with damp muslin throughout the test.

PASTEURISED CHEESE

In the Colonies, where dangers of over-acidity in milk are considerable owing to the warm climate and transport difficulties, the pasteurisation of milk for cheese-making may be resorted to as occasion demands. To generally recommend the practice, would be unwise for numerous reasons, chief among them being the extra labour and cost, and the opposition it would create to reforms, which are imperative to a sound and healthy milk supply.

The following particulars are kindly supplied by Mr Miles Benson of the British Dairy Institute.

The milk may be heated to temperatures between 150° and 170° F

The heating should be done quickly.

The milk should be cooled quickly after heating.

Starter should be added at the rate of 1 to 1¼ per cent.

The amount of rennet necessary to produce a good coagulation is 2 drm. to 3 gals. milk.

The curd should be cut fine.

Heating or scalding should reach 104°.

The curd tends to hold up moisture, and it should therefore be as firm as possible when whey is drawn.

Acidity will develop rapidly, and 0.8 to 0.9 at least is necessary at the time of grinding.

A dry curd is desirable.

Pressure should be applied for four days (heavy pressure).

Salt should be used at the rate of 1 oz. to 4 lb. curd.

The pasteurising of the milk gives an increased saline flavour to the curd.

Ripening.—The cheese will be slow in ripening.

In the early stages of ripening it may taste slightly bitter. This bitterness will disappear, as I have proved over and over again.

The cheese will be paler in colour. It will be much richer and softer in texture than cheese made from non-heated milk; and at all times the pasteurised milk cheese will excel in quality.

There will be 5 per cent. more weight when high temperatures are used in pasteurising.

The flavour is always clean, provided a clean starter is used, and there is more uniformity in the quality of the cheese.

Cheese Investigations

Stringy Milk and Pinhole Curd.—These two defects chiefly come from the same source, namely, sewage matter, and cheese-makers are familiar with the destructive effects of the micro-organisms in milk and curd. Mammary diseases of the cow are associated with a form of stringiness, but this may be entirely dispensed with as a general cause. In such cases the milk of occasional cows is usually affected, and to ascertain this a simple test may be profitably applied. Take a number of wide-mouthed glass jars, such as are used for jam or marmalade, and after sterilising with boiling water, name the jars after the different cows in the herd. Wash and dry the udders and teats of the cows. Draw a quantity of milk from the four teats until the jar is nearly full, and repeat this with every cow. Care must be taken to wash the hands after each "milking." Put the jars in a bath of warm water and place in a clean, airy room, and cover with thick muslin. In twelve hours examine the surface of the milk with a bit of iron that has been passed through a flame and afterwards cooled. Note the result in each case. Precautions must be taken to clean the metal after each operation, and not to disturb the milk more than is necessary. Let the milk coagulate firmly, and again test the surface for stringiness, also examine the sides of the curd for pinholes. Gently remove the contents of the jars, and carefully search the lower portion of each curd for similar defects. If stringiness is found in individual cases, the cause may be attributed to either infection in the teat passages or in the milk glands. Smell and flavour of the milk should also be noted, as this might assist in tracing errors to feeding, etc. If sufficient evidence has been obtained that the cows are not at fault, and this is usually the case, the investigator should direct his attention to an examination of the water supply, and the general sanitary arrangements of the farm. Here the danger usually lurks, if the fault is with the farmer.

Organisms of sewage responsible for stringiness in milk, and a pinhole condition in curd and cheese, may be divided into two classes. One produces blisters in coagulated milk, and for practical purposes has been named by the writer "Blister Microbe." The blisters vary in size, and contain a liquid possibly caused by the casein becoming dissolved. Surrounding the blisters the milk will show a stringy condition, which varies according to the development of the blisters and the activity of the organisms. This class of stringy bacteria would appear to thrive best in the presence of air. The other class also found in sewage matter is more active when the supply of oxygen is limited, and this is further shown by the destructive properties of the organism in cheese.

Observations made by the writer show that the food and drink of the cow may favour the activity of both pinhole and stringy bacteria; in other words, the milk becomes a more acceptable medium for the activity of the organisms. By a system of feeding, the acid or alkaline reaction of milk can be raised or lowered, and if the cows are permitted to drink stagnant water the milk is further endangered. There is good cause to believe that the organisms we are dealing with will develop more readily under such a condition. One class of bacteria has been shown to prefer an acid milk, and the other an alkaline.

The following investigations conducted by the writer will be of interest to cheese-makers. At a large cheese factory the manager's attention was drawn to a fibrous coagulation in patches on the surface of the milk after renneting. The presence of the sticky curd was more generally noticed during the process of cutting when the curd around the cavities of whey adhered to the knives, causing damage to the coagulated milk. After a careful examination of the vat a number of small holes were found in the bottom through which water was entering from the jacket. Bacteriological cultivations from the water showed that germs capable of producing stringiness were in abundance. The investigation was continued at another factory where stringiness in the curd and heaving cheese were proving very costly. After the draining of the whey, and the removing of the curd to the cooler, the presence of a milky liquid oozing into the vat from a joint near the bottom attracted the attention of the manager and the writer. Upon a close inspection being made, one tiny hole was found through which the water had access to the vat from the steam jacket underneath. Immediately this was observed the vat was removed and the holes soldered, also the jacket was thoroughly cleansed of the tainted milky liquid.

After the day's work was over, a brief examination of the cheeses in the curing-room was made, and a number of the new, as well as partly-matured, cheeses were found to be heaving, this being very pronounced in some cases.

No further loss was experienced with stringy curd at this factory.

Trouble at a third factory was reported, and, assisted by the information gained in the previous cases, the following practical experiment was conducted:—

A few cubic centimetres of water were taken from a drain that passed through the cheese-making room. Four sterilised jars were filled with pasteurised milk.

In Nos. B and D 3 c.c. of the water were delivered by means of a sterilised measure, and thoroughly mixed by changing the inoculated milk and shaking it up in two other sterilised jars, afterwards returning it to B and D; A and C were kept as controls. Twelve hours afterwards the four jars were renneted at the temperature of the milk (64° F.) with 5 c.c. of rennet diluted with sterilised water, and the jars were afterwards covered.

The following morning the coagulum of the inoculated jars was beginning to rise, and three hours afterwards the whey separated.

On the surface of the coagulated milk B, the same night, heaving of the curd had taken place, and on D numerous small holes, many covered over with air bubbles,

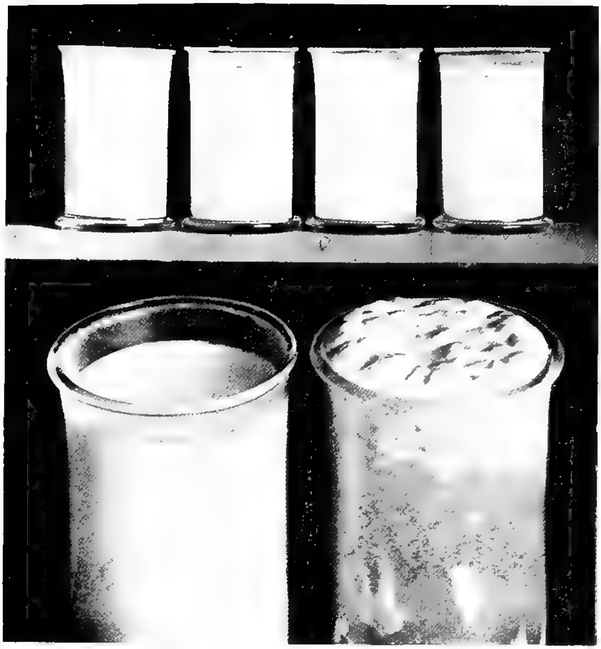
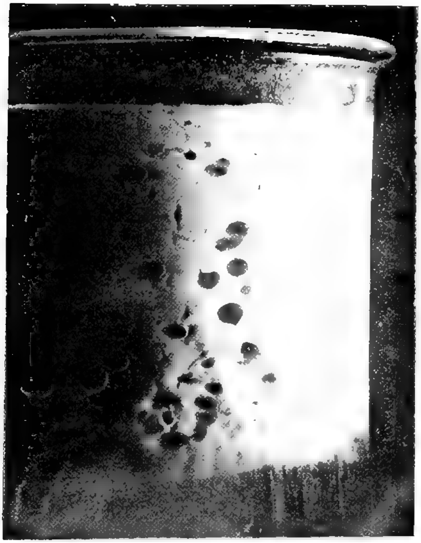


FIG. 82.—A and B—54 Hours after Renneting.



D—48 Hours after Renneting

FIG. 83.—A and C—Control Jars; B and D—Inoculated with 3 c.c. Sewage Water (Thomson).

were dotted around the coagulum, as shown in the illustration.

The control jars, or those without the sewage water, were in both cases unaffected in appearance at the conclusion of forty-eight and fifty-four hours.

Jar B continued to heave, and at the end of sixty hours the top was cut off with a sharp knife, and a fine honeycomb appearance showed itself, notwithstanding the very sticky consistency of the curd.

A second experiment was conducted to demonstrate stringiness in the curd. So pronounced was this condition after inoculation, that fine threads could be drawn inches above the surface of the curd, while the control jars were normal in adherence to parchment.

Further tests were made with the whey from the stringy curd, and one jar of milk was inoculated with the whey and curdled with rennet. The action of the bacteria destroyed the casein entirely, leaving only a white scum on the surface of the liquid.

Scientific investigation of supplies of tainted cheese confirmed that the trouble originated in the milk coming in contact with sewage matter in the making-room.

Pinhole Cheese.—A pinhole condition in cheese curd is a defect generally met with in hot weather. It is caused by an organism commonly found in sewage matter and which is also prevalent in fowl manure. In the building of poultry houses, the further distant they are from cow houses and milk-rooms the better. When in close proximity to the milk supply the dry manure is readily transported by wind and in this way contamination may be caused.

Pinhole curd differs from gassy curd, but the one is frequently confounded with the other. Gassy curd is a defect that commonly occurs in the milk of cows that have been fed on fermentive foods such as lucerne, clover, sainfoin, and silage.

When on an official visit to Tasmania from South

Australia in 1900, the writer's attention was drawn to a quantity of holey cheese in a shop window in Hobart. A sample was procured, and upon returning to Adelaide he conducted the following investigation.

Securing a small piece of the affected cheese, the organism causing the trouble was isolated and cultures prepared. The next step was to ascertain if the germ could live for any length of time in whey, and this was shown to be the case, proving that contamination will follow neglect to sterilise cans which previously contained affected whey, and the same applies to utensils used in the manufacture of cheese.

How the Investigation was Conducted.—A is a photograph of the original sample of pinhole cheese. The first duty was to cut the cheese with a sterilised knife, and after bringing a sterilised platinum wire into contact with one of the holes, a quantity of germ food was inoculated, and a plate culture prepared. When the organisms had developed into numerous colonies, inoculations of liquid media were made until the pinhole bacterium was isolated. B shows bells of gas which were produced by the bacteria. In conducting this test, agar was liquefied in a test-tube subsequently sterilised, and at a certain temperature the culture was introduced. After four and a half hours from inoculation, gas bubbles were numerous in the agar, and at this stage the tube was photographed. Further tubes were prepared to illustrate that the organisms preferred anaerobic conditions as seen in C. The shape of the bubbles in the tubes at full size was convex, but they had a ball-like appearance when small. Further observations were taken of the bubbles.

Milk Tests.—A quantity of fresh milk was procured. One half was heated to the scalding temperature of cheese curd, 100° F., and afterwards poured into two sterilised flasks. A preparation of the culture was then added, and the flasks were placed in the incubator at 95° F. Two additional vessels were kept as control samples. At the conclusion of thirty six hours the inoculated flasks were photographed. A pint of sweet milk was now heated to renneting temperature, 85° F., and inoculated with the culture. A few drops of dilute rennet were then added and thoroughly stirred. The flask was then set aside in the laboratory, and at the expiry of thirty six hours the top of the curd, which had risen considerably, was cut off, leaving a holey condition.

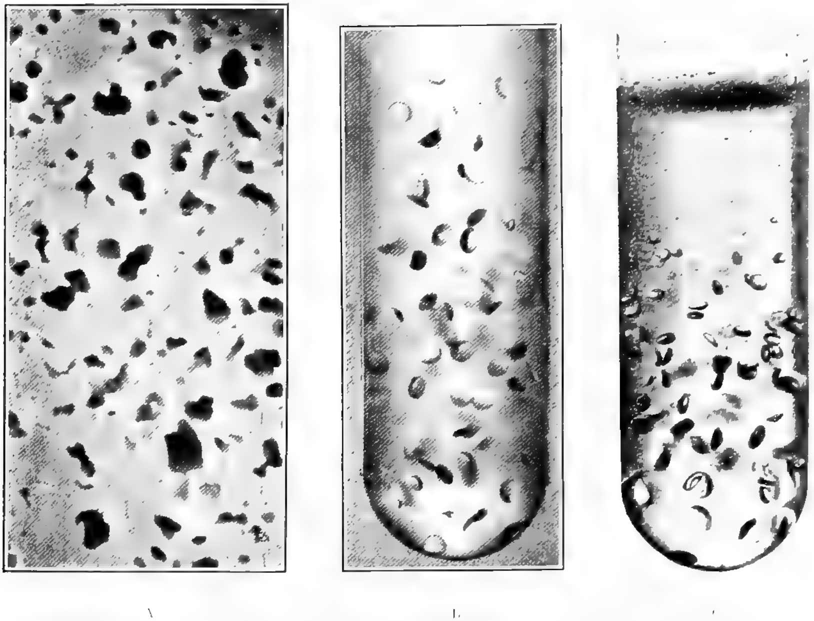
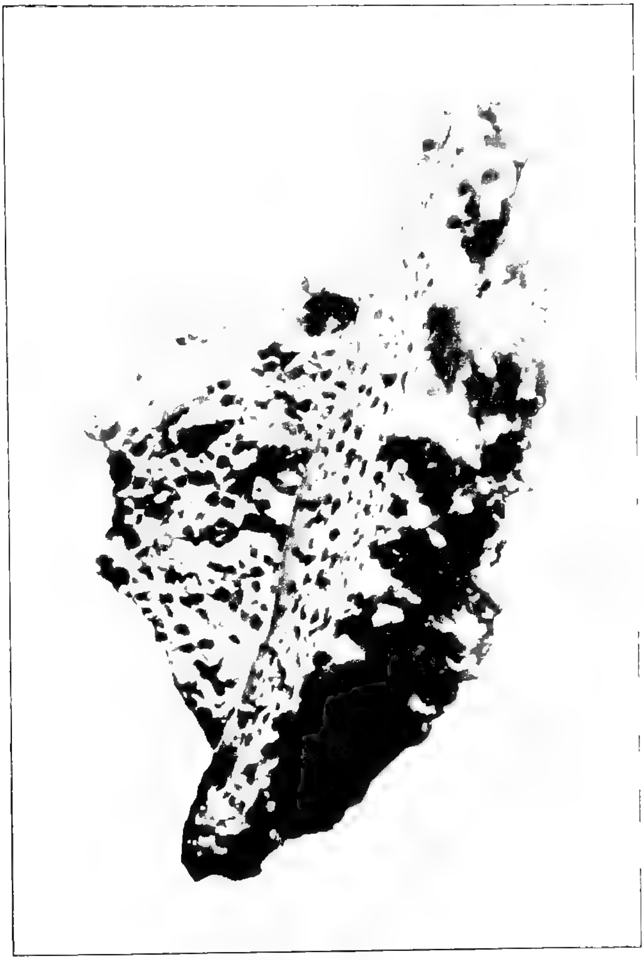


Fig. 84.—A, Original Sample of Cheese; B and C, Bells of Gas produced by Pinhole Organisms (Thomson).

Curd and Cheese Test.—A small cheese was prepared from milk inoculated with the culture. D shows a splendid example of pinhole curd, and E illustrates the open condition of the cheese a few days after manufacture.

When the pinhole evil is detected in a factory, drastic remedies are necessary in the cleansing of the factory and its equipment.



D

FIG. 85.—Pinhole Curd (Thomson).

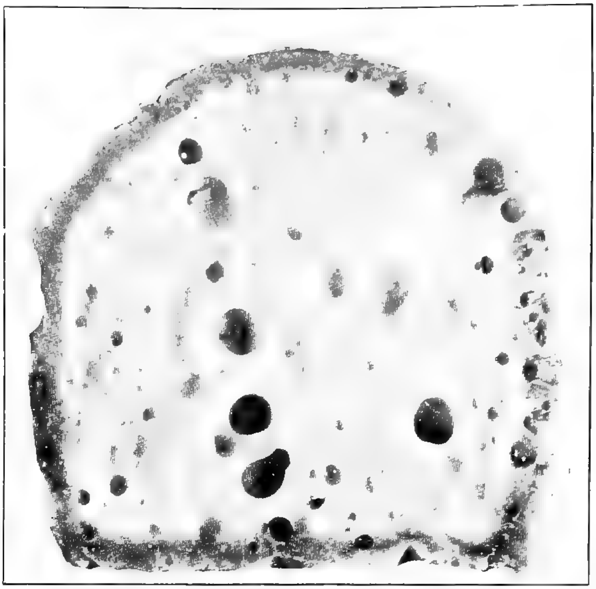


FIG. 80.—Cheese from Curd D (Thomson).

Cheese-making in France

A *résumé* of the manufacture of Gruyère, Roquefort, Port-Salut, and Pont L'Eveque will be given more to illustrate to the student features of considerable interest in the science and practice of cheese-making, and which he may not have had an opportunity of becoming acquainted with. The process of manufacture outlined is thoroughly characteristic of the making of those cheeses in France. Réaumur (R.) thermometer is used in each instance.

Gruyère.—This is a hard-pressed cheese. A French building for the manufacture of Gruyère usually comprises a making and a milk room, with a warm and cool room underneath.

The milk is put into low metal vats. A starter is used which produces the delicate flavour of the cheese. It is made in the following way:—

100 litres of whey are boiled, to which is added 5 litres of water and ½ litre vinegar. After precipitation of the casein, 50 litres are taken out and put in a vessel in which the ferment is to be prepared. The temperature is raised to 35°, 2 litres of vinegar and 1 litre of ordinary milk are added. The following day a quantity of the original liquid is mixed with this preparation and the whole is heated to 70° and left to ferment normally. The ferment is called "aisy." After adding a portion of the ferment to whey it is reduced by boiling, producing a clear liquid of a bluish tint and possessing a slightly sweetish taste. To this rennet is added. Milk is renneted with the "aisy" and coagulation occupies from 25 to 35 minutes. A soft curd is produced which gradually hardens at a cooking temperature of from 30° to 40°. To hasten the separation of the whey, the curd is cut into cubes and carefully stirred. Heat is applied and when the curd no longer glitters, the first stage of manufacture is complete.

The second part is the real cooking. The curd is slowly heated to 44°, then quickly to 52° and 60°; the time taken varies from 25 to 35 minutes. During heating the curd is persistently stirred, also for about 10 minutes after the scalding temperature has been reached. When the curd is firm enough it is allowed to settle in the whey for 5 or 6 minutes.

The curd is now put through a wet cloth, afterwards it is hooped, and put into the press. After the necessary treatment, the Gruyère is taken to the cool room, which is kept at 10°. On the second day it is salted as uniformly as possible. Six hours afterwards, salt is rubbed into one side of the cheese, with a woollen cloth. Two days later the other side is treated in the same way. After remaining eight to ten days in the cool room the cheese is transferred to the heated room. A steady temperature of about 18° is maintained, and at the end of three months the Gruyère is ready for the market.

Port-Salut.—Port-Salut is of two kinds; the small size being 18 cm. in diameter, 4 cm. high and weighing from 1 kilo. to 1 kilo. 200; the large size is 25 cm. in diameter, 5 cm. in depth, and weighs from 2 kilos. 100 to 2 kilos. 300.

Milk containing from 3 to 4 per cent. fat and slightly acid is generally used. Temperature of renneting is between 28° and 34°, and period of coagulation 35 minutes. After the whey is drawn off the curd is broken into very small pieces suitable for the mould.

The circular moulds are lined with muslin cloth and filled with the curd, which is pressed lightly with the hand. When the quantity exceeds 1 cm. the corners of the cloth are folded over, and the cheese is pressed. Pressing lasts from 10 to 12 hours, and during this period the cheeses are turned twice, and the cloth changed.

After pressing they are taken from the moulds, and put in the drying-room where they remain from 12 to 24 hours. The cheeses are afterwards transferred to a heated cave.

To aid in the formation of the coat the Port-Salut is dipped every day in salt water, and the outside surface is rubbed with a damp cloth. After a month the cheeses are packed in small cases of light wood, and are ready for sale.

Roquefort.—The making of this cheese was for a long time in the hands of the farmers. It might be said that the industry was centralised in the caves of Roquefort, where the cheeses were matured. Industrial societies have now been established to carry on the manufacture of the cheese.

Milk is renneted at 26° to 30°. Coagulation takes place in from one and a half to two hours. The curd is put into a cloth of large mesh. There it is cut and turned with care, and then moulded. The moulds are of tinned steel, 20 cm. in diameter, 9 to 10 cm. high; the bottom and sides are perforated. Having placed a layer of curd in the mould, it is powdered over with mouldy bread, prepared by placing in a cool cave a baking of wheaten dough and rye flour to which vinegar has been added.

A second layer of curd is kneaded equally and powdered with mouldy bread, and a third layer of curd forms the upper part. The rôle of the mouldy bread is to introduce the green mould, *Penicillium glaucum*, which plays the principal part in the maturing of the cheese.

The moulds are placed on drainers in a room at 18°, and are turned three times the first day, and four times on the three following days. The cheeses are washed in tepid water, and then placed in the dairy cellar at a low temperature, where they remain for eight days.

At the conclusion of this period they are packed in crates (each containing twenty-four cheeses). Waggons provided with tanks take the Roqueforts to the caves preferably by night. On arrival they are classed and salted all round and on the top. The cheeses are now piled in threes on the ground, and the following day the other end is salted. After two days the surface salt is rubbed in with a cloth. A sticky deposit afterwards forms on the surface, and to remove this the cheeses are brushed by a machine. The reason for piling the Roqueforts is to diminish the contact of air, and to hinder the development of aerobic germs on the surface. It is necessary to aerate the interior of Roquefort cheese, and for this purpose they are passed over a machine provided with a series of needles which perforate the crust and allow the penetration of air.

The cheeses are returned to the cave.

The natural caves of Roquefort have all the conditions which favour the perfect maturing of the cheese. The average temperature is 8°, and currents of fresh and moist air are kept in circulation. Finally the cheeses are placed on the ground 5 or 6 cm. apart. A white mould grows on the cheeses, which is scraped off at the end of two months.

This favours the action of the *Penicillium glaucum* mould, the *Bacillus firmitatis*, and the *Micrococcus meldensis*, which give to Roquefort its particular aroma and flavour.

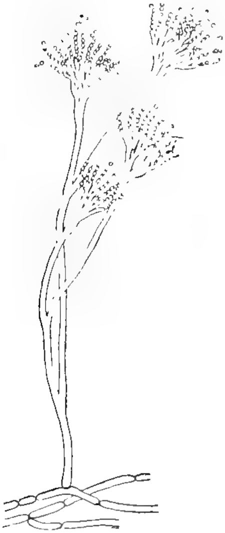


FIG. 87.—*Penicillium glaucum* Mould.

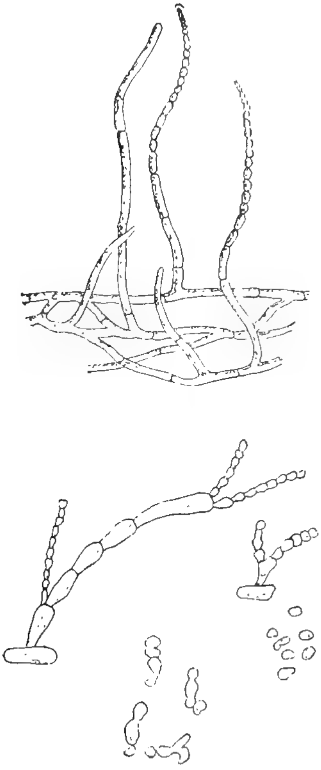


FIG. 88.—*Oidium lactis* Mould (Swithinbank and Newman).

Cheeses are made from January to August—the lambing period.

Pont L'Evêque.—There are three varieties of this cheese. First quality is made from sweet milk in the months of September and October, second from milk partly skimmed, and the third quality from skim milk.

The milk is heated to 35° or 40° and coagulated in twenty minutes. The curd is cut with a wooden knife, then with the curd slicer. The whey is run off, and the curd is put on straw or reed mats, where it drains. Occasionally the curd is covered with a cloth to prevent chilling before it is put into the square moulds. The moulds are turned eight to ten times during the first quarter of an hour, then the cheese is put on a very dry mat, and turned five or six times during the day.

Forty-eight hours after the filling, the cheeses are taken from the moulds, salted, and placed in the drying-room on hurdles covered with straw. During the three or four days that the Pont L'Evêque's are in the drying-room, they are turned once a day. The cheeses are then taken to the cellar and put in boxes. Ripening advances rapidly, especially if the cheeses are turned every second day.

The skim milk cheeses remain three months in the cellar, while the whole milk cheeses are ready in from 20 to 25 days.

CHEESES MADE IN BRITAIN

Hard-pressed.

Cheddar.
Cheshire.
Lancashire.
Leicester.
Gloucester (single and double).
Derby.
Wiltshire.
Cleveland.
Berkshire.
Dunlop.
Caerphilly.

Blue-veined.

Stilton.
Wensleydale.
Gorgonzola.
Dorset Blue.

Soft Cheese.

Camembert.
Cambridge.
Coulommier.
Cream cheese.

Other Varieties.—Pont L'Evêque, Bondon, Gervais.

Cheshire.—In the hard-pressed class, let us consider the Cheshire, which has a close relationship to cheddar. In England the popular size of a Cheshire is about 13 in. by 13 in., and from 65 lb. to 70 lb. weight.

The milk for a Cheshire is very similar in condition to that required for cheddar, but it is considered desirable to have it sweeter, testing from 22 to 25 seconds.

Colouring is added at the rate of 1 dram to 5 gals., and well stirred into the milk for a period of 10 minutes. The time of coagulation of the milk is the same as in cheddar, but a finer-cut curd is required, with an acidity in the whey of about 0.13. After cutting, the curd is stirred with the hands for about 20 minutes, to avoid loss of fat and casein, which would result if the rake were used. Heat is applied, and the temperature is gradually raised to 90° F., the cooking being continued for an average of one hour. After scalding, the curd is allowed to settle in the whey or "pitch," as it is sometimes called, until it contracts and leaves a clear space around the sides of the vat. On reading 0.17 of lactic acid, the whey is drained off. The curd is then rolled up, and subsequently placed on a rack in the bottom of the vat and broken up. When it has an acidity of about 0.6, and feels silky and flaky, the curd is ready to mill. Compared with cheddar, it is milled much finer, and is salted at the rate of 1 oz. to 3 lb. When hooping, no pressure is applied with the hands, and the cheese must be put into a room having a temperature not lower than 70° F. The same evening the cloth is renewed and the cheese is left to drain until the following morning. It is now put into the press at a pressure of 6 cwt., followed by 10 cwt. for the first day, 15 cwt. for the second, 20 cwt. for the third, and 25 cwt. for the fourth. When taken to the ripening-room, Cheshires should be turned twice daily for the first fortnight.

Soapy cheeses which bulge and heave are due to insufficient acidity, and this is what one must be careful to guard against in making Cheshire cheese.

Stilton.—For stilton cheese-making the milk must be perfectly fresh and sweet. Fifteen gallons of milk are required to make one cheese. Rennet is added at the rate of 1 dram to 4 gals. at a temperature of 83° F., and is stirred into the milk for 6 minutes. In 1¼ hours the coagulated milk is ladled out into cloths suspended over a drainer, where it is allowed to drain and lie in the whey for 2 hours; afterwards the whey is run off. The cloths are usually tightened at the end of 1 hour from draining, and at intervals of 2 to 3 hours; but care must be taken not to overdo the tightening. When the curd is sufficiently firm to handle, it is emptied into coolers, and allowed to remain in its whey until the following day. When 0.8 per cent. of acid has developed, salting is proceeded with, 1 oz. of salt to every 4 lb. of curd being considered sufficient. In hooping the curd, hand-pressure must be applied gently. The green cheeses are now taken to another room to drain, which usually occupies about seven days, according to the acidity of the curd and the temperature of the room. The next step is to remove the hoops, scrape the cheeses all round, also on top and bottom, and bandage and replace the hoop; continue to do this daily for four days. At the expiry of that time the stiltons are placed in a drying-room, which is kept free from draughts. The cheeses must be closely watched, and when a crust is seen to form, with no appearance of moisture on the outside, they are placed in the ripening-room.

Coulommier.—Three gallons of sweet milk at a temperature of 84° F. are renneted with ½ c.c. of rennet, and stirred for 5 minutes. Six hours are usually required for coagulation, and during the first 3 hours the milk is stirred at intervals to prevent the cream rising to the surface. When the milk is coagulated the curd is ladled into double moulds, placed on straw mats having boards underneath. After it has settled into the lower half of the mould, the cheese is turned. When sufficiently firm, salt is rubbed into each side several times. The period of ripening for Coulommier is from 5 to 6 weeks.

Cream Cheese.—Six quarts of cream at 70° F. are coagulated with 12 drops of rennet. After stirring for 5 minutes the cream is left for 24 hours. It is then ladled into cloths and hung up for 12 hours to drain. Every 4 hours the curd is scraped from the sides of the cloth to facilitate the escape of the whey. A weight is put upon the cheese for 24 hours, and the curd is scraped a couple of times during pressing. It is then ready for the mould.

Refrigeration

Lower Temperatures Required.—When factories are thoroughly equipped with refrigerating machinery the control of temperatures will prove of the highest gain to the manufacturer. In margarine works, where large quantities of separated milk are ripened, agitators of very simple but effective construction are used, and the excellent results obtained are conclusive proof of the value of keeping the milk in gentle circulation, and at a temperature which is found by experience to be associated with the finest acid flavours. There should, however, be no universal rule in the ripening of milk or cream at a standard or fixed temperature. 70-75° F. might give the best results in some countries or districts, while 65-68° F. would be found more suitable in others of a different climate. It is certain, however, that ripening in the summer months at a lower temperature than is customary would be productive of a better flavour in milk or cream, and a higher keeping quality in the manufactured product. And the same applies to churning, for where it is possible to churn cream at from 46-48° F., the gain is greater than if a higher temperature were adopted. The following are the results of tests which were conducted to ascertain the effects of temperature, purity of the atmosphere, and the ripening qualities of cream on the flavour of the acid produced in the product;—

Temperature of Ripening.	Condition of Atmosphere.	Ripening Qualities of Cream.	Flavour of Acid Produced.
75° F.	Pure	High	Very good.
71° F.	,,	,,	Excellent.
67° F.	,,	,,	Very good.
75° F.	Stale	Medium	Inferior.
71° F.	,,	,,	,,
67° F.	,,	High	Fair to good.

In the country and particular district where the tests were made, 67-70° F. would be considered the most suitable temperature for cream ripening. The same principle applies to churning, as this book has already shown. It is therefore an error to say that cream should be churned at a certain temperature, before due consideration has been given to climate and other vital conditions which are inseparable from successful butter-making. Mistakes in temperature and defects in butter should be corrected by the instructor at the factory or the farm, and not by correspondence, as is frequently attempted.

Tests for Temperature of Churning—A large quantity of cream was ripened, and then quickly lowered to the temperatures given below. As each degree was reached, an equal portion of the cream was run into churns and made into butter, with the following result:—

Temperature of Churning.	Flavour of Butter 1 Day Old.	Flavour of Butter 4 Days Old.	Flavour of Butter 1 Month Old, Refrigerated at 5° F.
52° F.	Weak	Good	Good.
50° F.	More pronounced	,,	,,
48° F.	,,	,,	Very good.
46° F.	,,	,,	,,

At the lower churning temperatures the butter also had the best texture, and the percentage of water was lower compared with the other samples. With thoroughly clean and wholesome cream, a pure atmosphere, and correct ripening and churning temperatures, the butter produced will retain its fine properties for weeks at a temperature of 32° F. But such a combination of good conditions is not usually experienced, therefore it is necessary to guard against defects in butter by chilling to very low degrees of cold from the time the butter is set until disposed of to the retail shops. A high temperature is the ally of deterioration, and this is proved by losses which amount to millions of pounds sterling annually. In Australia, the Argentine Republic, and Siberia lower temperatures are particularly necessary, as there is a high proportion of inferior grades of butter manufactured in these countries. There are only two remedies within reach of the industry of a country, and these are to raise the standard of quality by improved methods, and to retain the good flavour in the butter by low and steady temperatures.

There is a splendid field for the investigator, and oversea Governments should not hesitate to spend money freely in order to thoroughly demonstrate the necessity for reforms in the refrigeration of butter. The writer will take the liberty to express the urgency for energetic action, by the subjoined figures, which represent the present average quality classification of butter imports.

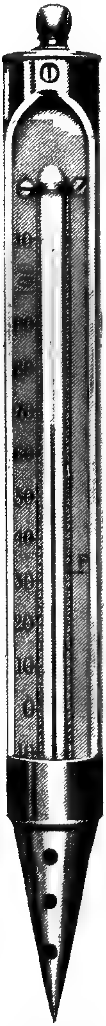


FIG. 89. Butter Grader's Thermometer.

	Percentage of Good Butter.	Percentage of Secondary and Inferior Grades.
[1] Denmark	100 "Lur"	...
[1] Sweden -	88 "Rune"	...
New Zealand -	70	30
Australia	50	50
Argentine	45	55
Siberia -	35	65

[1] Lur and Rune brands represent first grades of butter. The percentages given above by the Produce Commissioners for Denmark and Sweden are for 1912.

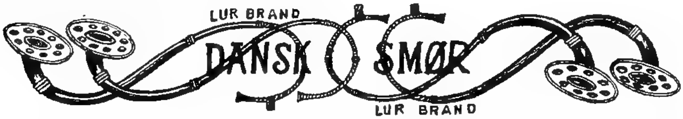
Low grades of butter depend entirely upon temperature to prevent rapid deterioration.

Why, then, should so little be done to correct existing errors in storage temperatures? It might further be stated that some butters are known to "jump" in flavour from a good quality to a lower grade in a very short time, if the temperature favours the change, and this will also apply to all butters that come under the category of "slightly off, otherwise good," at the time of manufacture.

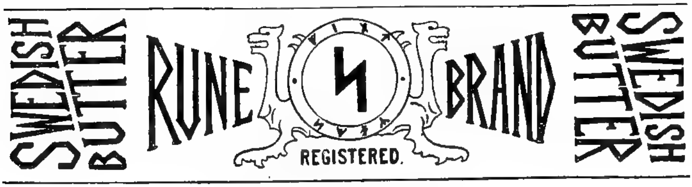
The writer has conclusively proved that butter is carried from Australia at temperatures that favour fishiness and staleness, and it would seem incredible that so little has been done to remedy this very serious error. In all cases there should be a stipulation in shipping contracts to chill butter to a lower degree, and the price incurred would be infinitesimal compared with the enormous losses that temperatures are responsible for. But the storage of export butter in Australia is not free from fault, and shipping companies have reason to take exception to the temperatures of produce when it reaches the steamers.

For further consideration of this subject readers are referred to a chart on page 198 of "Milk and Cream Testing."

As previously stated Denmark and Sweden are safeguarding their exports to Britain by the use of State brands as illustrated below.



Danish State Butter Brand.



Swedish State Butter Brand.

The reputation of these brands is most carefully guarded by the Danish and Swedish Produce Commissioners in London. These officials keep in close touch with merchants, who assist them to trace their produce to its various sources. Any defects in quality or distribution are quickly ascertained. The question of temperature is closely studied, and no butter leaves these countries before it is set, and the flavour fixed.

Refrigeration and Weak Butter

It has been stated that the butters of some countries are weak, and the following are a few of the terms used to describe this condition : –

Bodyless butter, lifeless, raw, spongy, feeble, pasty, poor consistency, without grip and without character. Correctly speaking this is not a fault, it is largely a climatic weakness which may be aggravated by a number of conditions. Some of the finest brands of butter produced in the British Islands are weak, although the delicate flavour and aroma may not be excelled in other parts of the world. It is undoubtedly a very costly weakness, as the butter has reduced keeping properties, and does not give confidence to buyers. It is marketed for immediate consumption and it would appear to be a grievous error on the part of manufacturers to have allowed this "criticism" on their produce to become established, as weak butter and waterlogged butter are recognised to have a relationship. This book contends that certain breeds of cows and watery and immature food will produce milk that is weak in texture, and in the treatment of the cream and manufacture of the butter evidence is given to show that much can be done to strengthen the butter and give it a solidity that is inseparable from superfine produce. Take pasteurisation, the use of starters, and low temperatures as examples of helpful practices. Much of the British made factory butter is raw or green when sold ; it is not allowed to set and the flavour to become fixed before leaving the factory. This can only be done at certain temperatures. In other words the butter goes direct from the churn to the market, and its weak condition—call it constitutional or heredity if you like—is thereby encouraged to the detriment of price and reputation. Refrigeration is one of the strongest links in the chain of successful dairying, and its absence or the use of defective plant will go far to liquidate butter factories and discredit the industry.

Thermographs for Ships' Cool Chambers

Although the thermograph has not yet attained its highest degree of perfection, it is sufficiently reliable to entitle it to be called a practicable instrument. In the use of the thermograph there are one or two points which require close attention. Firstly, the correct setting of the pointer or indicator at the commencement of the voyage, and for this purpose a standard thermometer only should be used. Secondly, the thermograph should be contained in a specially constructed box provided with springs to reduce vibration, and for the purpose of keeping the instrument level in the cool chambers. Thirdly, it should be placed in the centre of the cargo of perishable produce, and not at the top or bottom, for reasons which are obvious. If situated where there is a blast of air, and this mistake is not uncommon, the reading on the chart will be irregular, and where copying ink is used it will be liable to smudge the chart and injure the tracing.

The use of the thermograph should be extended to all stores in the Colonies employed for the chilling of export butter and cheese. Such a provision would be in the interests of the dairying industry and the shipping companies; also thorough care should be exercised in the preservation of butter after arrival in Great Britain. The Canadian Government are using close on three hundred thermographs in steamships, cool cars, and stores with successful results, and there is absolutely no reason why every ship carrying butter from Australia should not have the most reliable of these instruments fitted up in the chambers. Unfortunately, there is a good deal of bitter resentment to the use of the thermograph; but when all things are carefully considered, strong evidence will be found in support of the "tell-tale" thermometer. The following good and faulty temperatures are shown by the thermograph:—

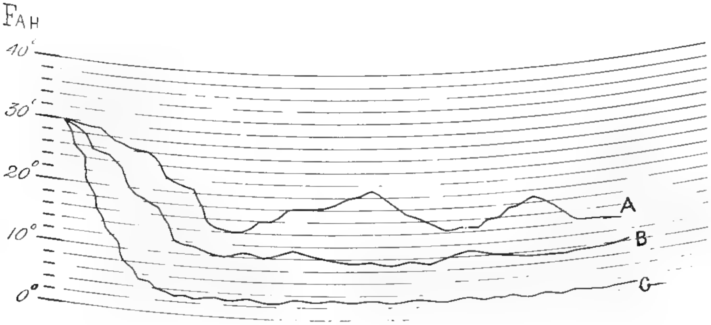


FIG. 90.

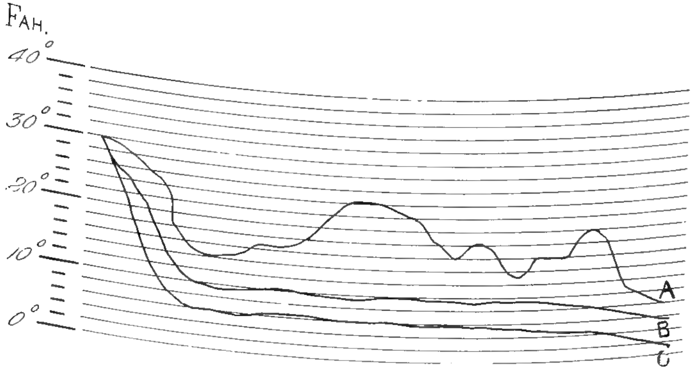


FIG. 91.

A would breed fishiness and other taints in butter owing to high and fluctuating temperatures.

B would preserve the butter against the growth of ruinous taints and plant flavours.

C would practically destroy the possibilities of fishiness, and other taints destructive to Australian butter would absolutely cease to develop.

The examination of the chart on arrival of steamers carrying butter from Australia would be of the greatest value to those investigating defects in colonial produce, and it would be the means of proving to shipping companies under what conditions the best results are obtained.

Grading.—There is no denying the fact that the classifying of butter in Australia has been injured through faulty temperatures, and this should be sufficient to cause better arrangements to be made for the future preservation of butter. It proves to the writer that secondary qualities advance in deterioration during transport to England.

Erroneous Objections.—Those opposed to thermographs frequently use as an argument that the extra cost of reducing the temperature is against any change from the present arrangement. This is not borne out by fact, and refrigerating engineers on board ships admit that in well-equipped vessels no difficulty is found in keeping the temperature of chambers at a very low degree. In steamers supplied with refrigerating machinery of the old type this cannot be done so readily, and the cost would be greater. But why should the dairying interests of Australia suffer because some shipping companies are not disposed to equip their vessels with up-to-date refrigerating plant?

We are also informed that it is impossible for refrigerating engineers to keep a steady temperature in the chambers even during a long run between ports. One can quite understand the temperature rising and being unsteady owing to the loading of the vessel, but there is no reason why an even temperature should not be maintained, for example, between Australia and Durban, and Durban and London. The general practice is to run the machinery intermittently, which causes fluctuations of temperature, instead of running continuously "one leg," as the engineer would call it, after the chambers are down to the correct degree. The thermograph will very clearly show when this is done.

It is absurd to say that very low shipping temperatures would "injure" butter. The writer showed in 1900 that a low acidity in cream acted as a splendid preventive against a fishy flavour, and later he was able to conclusively prove that this and other ruinous taints and weedy flavours in butter, which have cost Australia millions of pounds in reduced prices, and caused irreparable injury to her reputation, can be prevented and kept under control by low and steady temperatures. To further confirm these deductions Australia cannot do better than arrive at an arrangement with a steamship company to carry experimental shipments of butter to London at different temperatures. The Departments of Agriculture of the Commonwealth are in a position to conduct practical research of inestimable value to dairying in the cool chambers of vessels carrying produce to the United Kingdom. It is strange, but nevertheless true, that meat is generally carried at a proper temperature, simply because it is a commodity that very quickly challenges faulty temperatures, but although butter is, scientifically speaking, a hot-bed of fermentation and a breeding-ground for taints, and requires a distinctly lower temperature than meat or mutton, it is passed over with unfortunate results.

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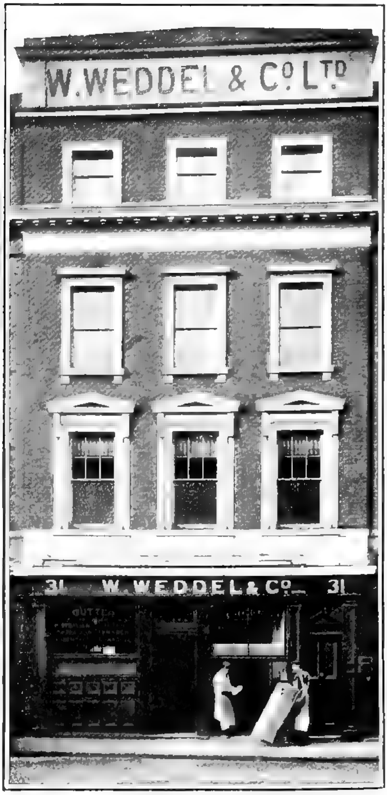

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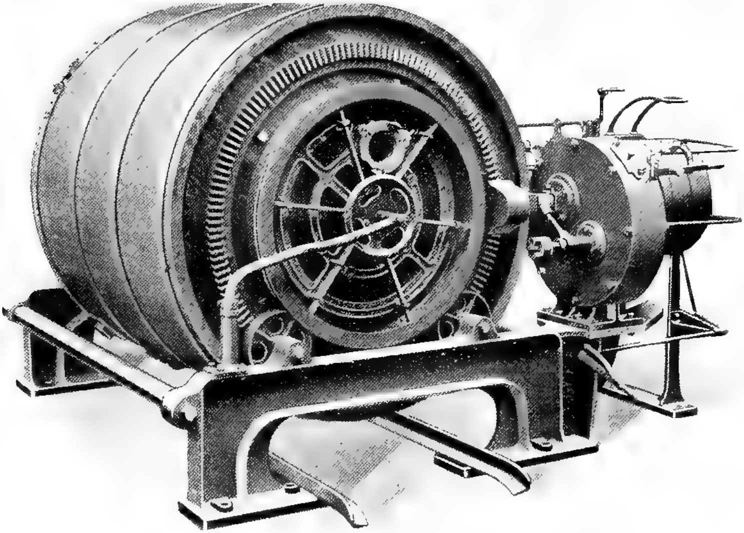

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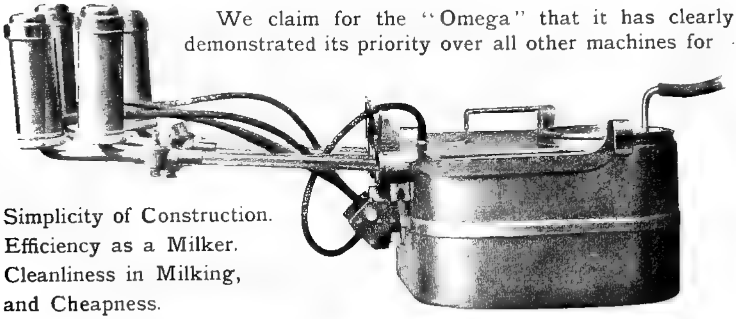

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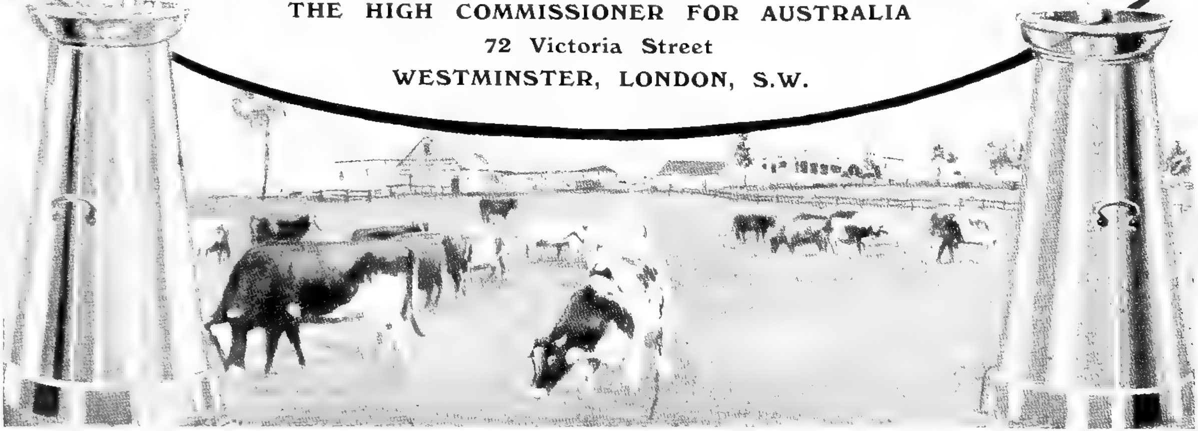

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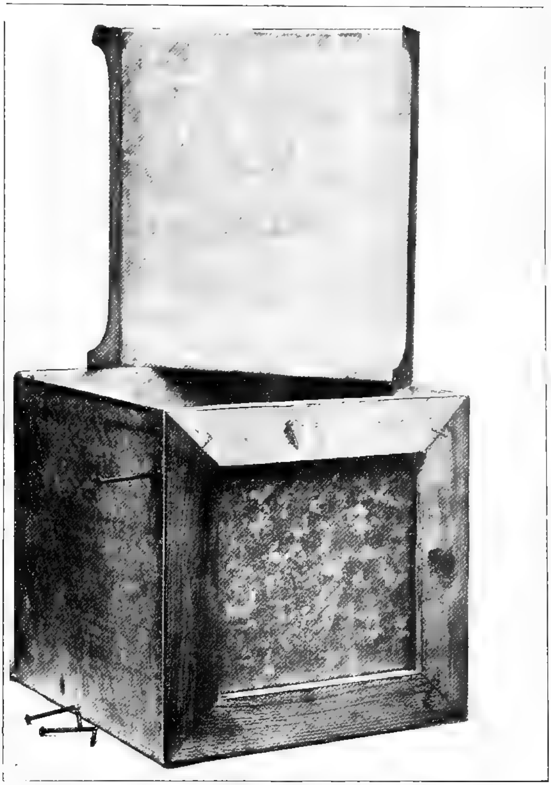

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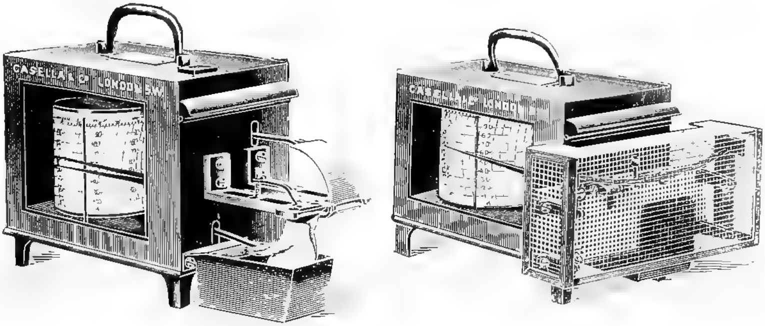

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